EZ-ZONE® RMZ4 EtherCAT®

User's Guide

EtherCAT® Adapter

0600-0103-0000 Revision A.5

TOTAL CUSTOMER SATISFACTION
3 Year Warranty

EtherCAT® Conformance tested

WATLOW

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8.15 Direct Analog Output ..... **Error! Bookmark not defined.**
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Symbol	Explanation	Symbol	Explanation
	ESD Sensitive product, use proper grounding and handling techniques when installing or servicing product.		Unit protected by double/reinforced insulation for shock hazard prevention. Functional earth ground connection may be present.
	Do not throw in trash, use proper recycling techniques or consult manufacturer for proper disposal.		Enclosure made of Polycarbonate material. Use proper recycling techniques or consult manufacturer for proper disposal.
	Unit can be powered with either alternating current (ac) or direct current (dc).		Unit is a Listed device per Underwriters Laboratories®. It has been evaluated to United States and Canadian requirements for Process Control Equipment. UL/EN 61010-1 and CSA C22.2 No. 61010. File E195611 QUYX, QUYX7. See www.ul.com
	Unit is a Listed device per Underwriters Laboratories®. It has been evaluated to United States and Canadian requirements for Hazardous Locations Class 1 Division II, Groups A, B, C and D. ANSI/ASI 12.12.01-2012. File E184390 QUZW, QUXW7. See www.ul.com		Unit is compliant with applicable European Union Directives. See Declaration of Conformity for further details on Directives and Standards used for compliance.

3 OVERVIEW

The Watlow EtherCAT® Adapter allows integration of the EZ-ZONE RM systems into larger EtherCAT® controlled processes. EtherCAT® is an industrial control network that uses standard 100 Base-T Ethernet wiring to provide very fast access to controllers and their data points. The Watlow EtherCAT® Adapter conforms to the EtherCAT® Temperature Controller Specific Device Profile ETG 5003-2060. It has been conformance tested by an ETG test facility.

EtherCAT® provides access to system parameters using a CAN open interface scheme. The ETG 5003-2060 specification describes the data point organization. The data is accessed via SDO (Service Data Objects) during startup and configuration and via PDO (Process Data Objects) exchange during operation. SDO access is transactional in nature, the master asking for or setting a value in the slave device. The device supports reading and writing an entire index in one transaction. The feature is called SDO complete. PDO data is a continuous stream of data from the master and back from the devices at high speed.

USB and Bluetooth® interfaces are provided for configuration and system monitoring from a PC or tablet devices. Bluetooth® is an option so it can be excluded for production equipment where wireless security is important.

The Watlow EtherCAT® Adapter can also host a legacy communications adder card. This card provides additional connection points for Modbus®, DeviceNet™ and Watlow Standard Bus. These cards are intended to extend the network beyond RM modules to include displays like Watlow Silver Series and EZ-ZONE EZK and legacy controllers such as the EHG® SL-10. The Watlow EZ-ZONE ST and EZ-ZONE PM may be integrated from the “C” connector without requiring a Legacy Communications card.

The Watlow RMZ4 EtherCAT® Adapter operates within a larger RM system. The RMZ4 part number defines the number of loops supported. The largest system supported is 48 loops. The RMZ4 module does not support ad-hoc RM modules and function block programming. Function blocks in the RMS and RME I/O modules may be programmed using EZ-ZONE Configurator software via the USB port.

The RMZ4 supports 4 optical temperature sensors for high RF or voltage environments like plasma, power distribution transformers, or medical imaging.

Features

- ETG Conformance Tested by ETG

  EtherCAT Conformance tested
- ETG.5003.2060 compliant EtherCAT®
- Up to 48 control loops with EZ-ZONE RM, ST, or PM controllers
- One process and one deviation alarm per loop
- USB device serial port emulation supporting EZ-ZONE Configurator and Composer
- Bluetooth® serial port emulation serving system information via XML (Optional)
- Modbus® Slave RS-485 port to host an HMI touch screen (Optional)
- Modbus® Master RS-485 port to monitor up to 16 EHG line heaters (Future Option)
- Extra Standard Bus RS-485 port for EZK remote display or PC tools connection (optional)
- Optional 4 RF-immune fiber optic sensor.

4 MOUNTING AND DIMENSIONS

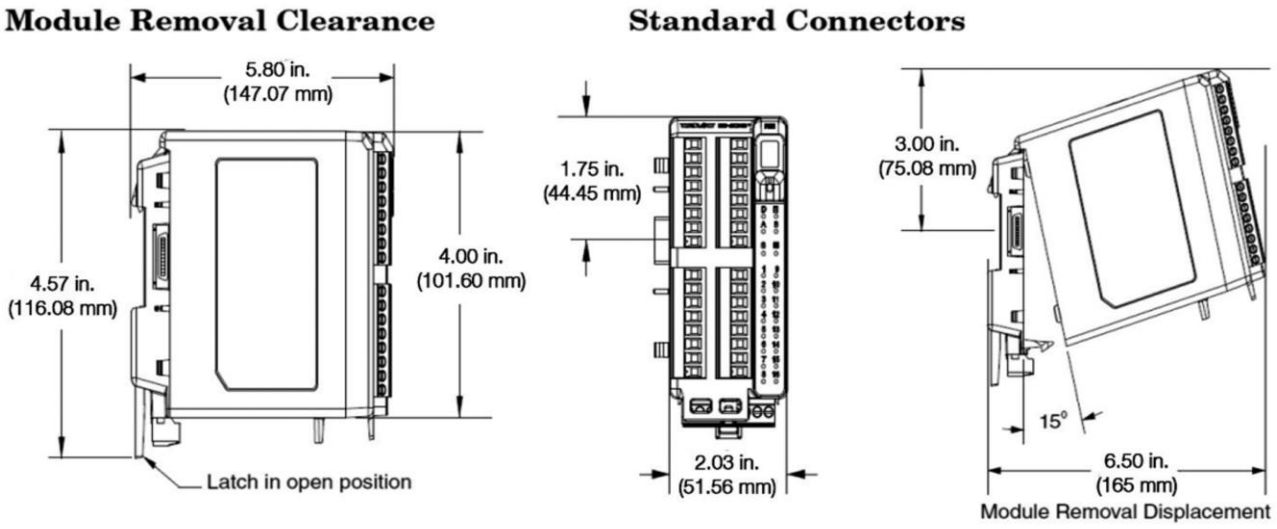
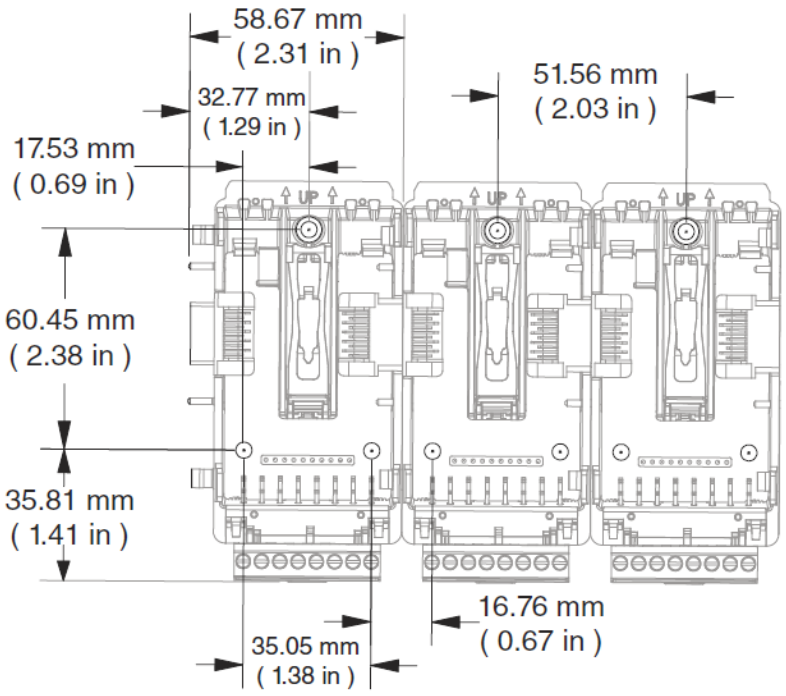


FIGURE 1 - DIMENSIONS



Recommended chassis mounting hardware:

1. #8 screw ¾" Long
2. Torque to 10-15 in-lb
3. No washers

5 CONNECTIONS AND WIRING

5.1 RMZ4 WITH UP TO 48 CONTROL LOOPS

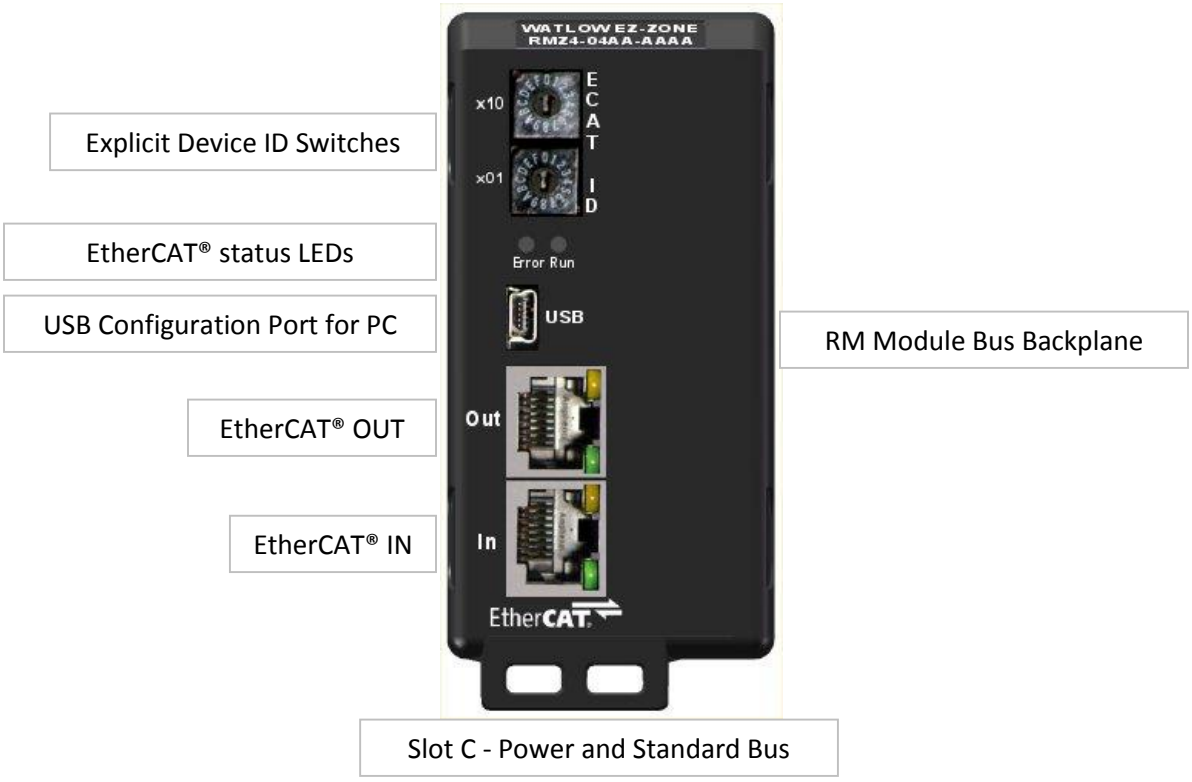


FIGURE 2 – CONNECTIONS POINTS FOR RMZ4-__AA-AAAA

5.2 RMZ4 WITH OPTICAL SENSOR CARD

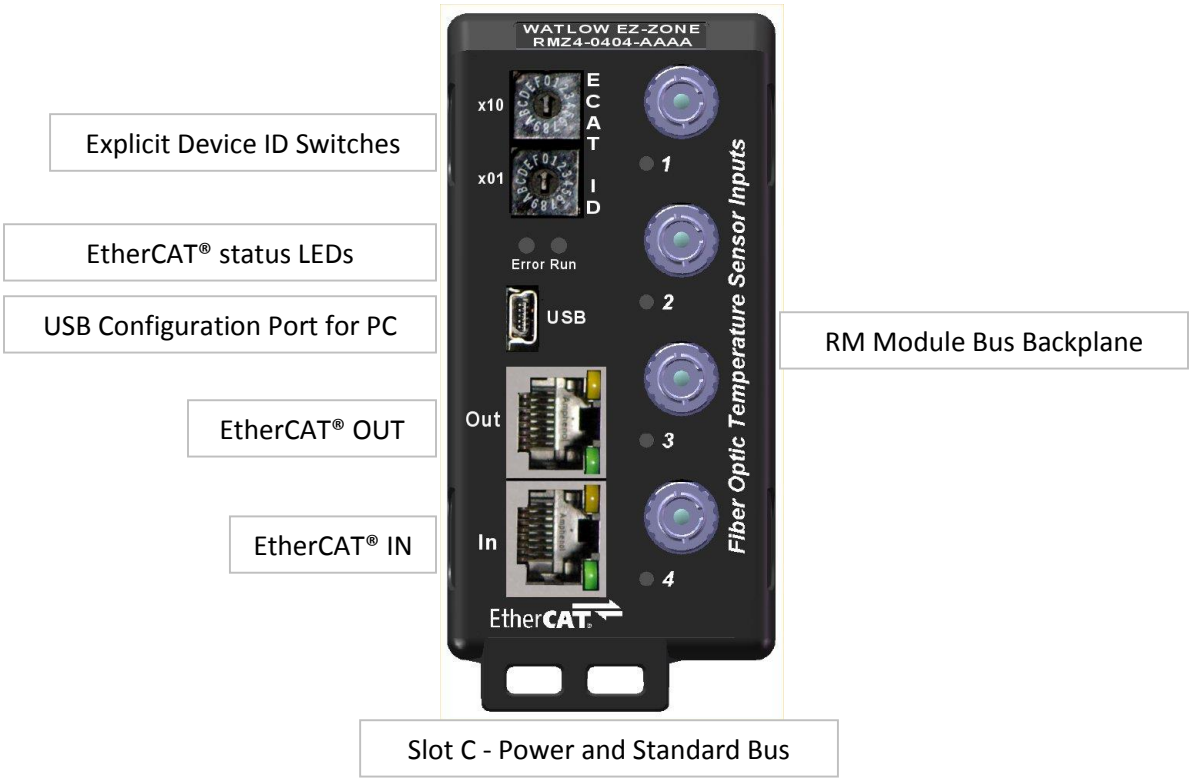


FIGURE 3 – CONNECTIONS POINTS FOR RMZ4-XX04-AAAA WITH OPTICAL TEMPERATURE SENSING

The RMZ has an option for using fluorescent decay via fiber optic cable for sensing temperature in high RF environments. The number of channels of optical sensing is defined in the model number xxxx-xx04-xxxx. The fluorescent probes are available from Watlow. The range is generally -100 to +200C without special probe construction. Each probe is connected via a bayonet style ST connectors. To use this input in a control loop define the bus as Optical (option 4) and select instance 1, 2, 3, or 4.

5.3 RMZ4 WITH SERIAL COMMUNICATIONS CARD AND BLUETOOTH

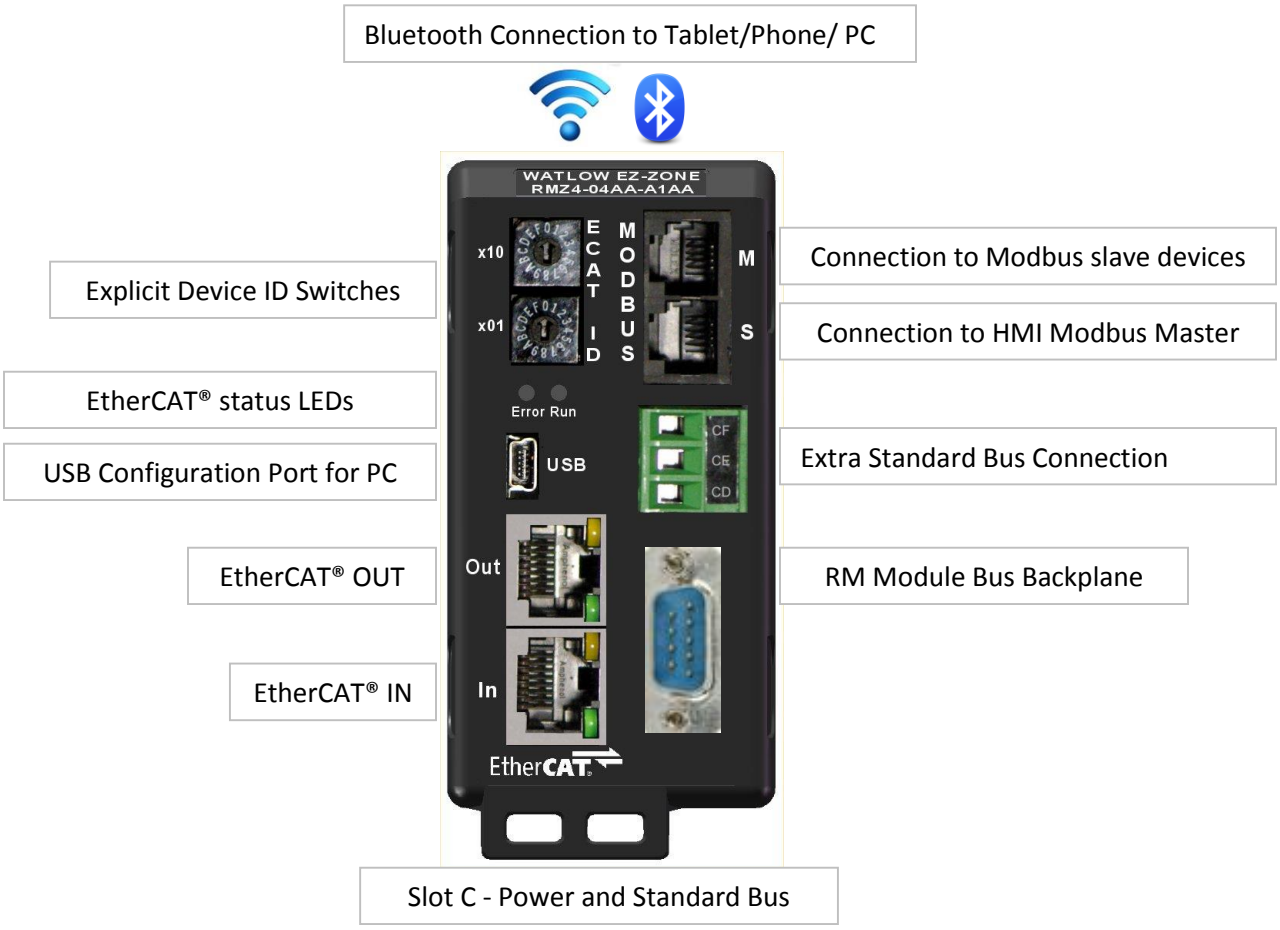
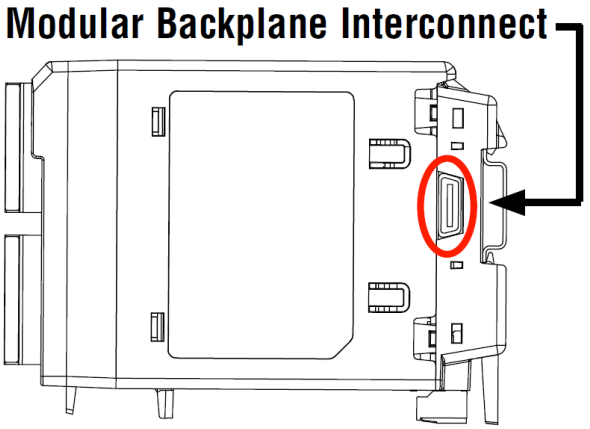


FIGURE 4 – CONNECTION POINTS FOR RMZ4-XXAA-11AA WITH SERIAL COMMS CARD AND BLUETOOTH

5.1 RMZ4 WITH DEVICE NET AND HMI MODBUS

5.2 RM System Connections

The RM system controlled by an RMZ4 module can be installed as stand-alone modules or can be interconnected on the DIN rail as shown below. When modules are connected together as shown, power and communications are shared between modules over the modular backplane interconnection. Therefore, bringing the necessary power and communications wiring to any one connector in slot C is sufficient. The modular backplane interconnect comes standard with every module ordered and is generic in nature, meaning any of the RM modules can use it.



The modules can also be mounted in different locations and the backplane connected via wires in a *Split Rail* configuration as shown in the figure. Notice in the split rail system diagram that a single power supply is used across both DIN rails. One notable consideration when designing the hardware layout would be the available power supplied and the loading effect of all of the modules used.

Watlow provides three options for power supplies listed below:
1. 90-264VAC to 24VDC @ 31 watts (Part #: 0847- 0299-0000)
2. 90-264VAC to 24VDC @ 60 watts (Part #: 0847- 0300-0000)
3. 90-264VAC to 24VDC @ 91 watts (Part #: 0847- 0301-0000)

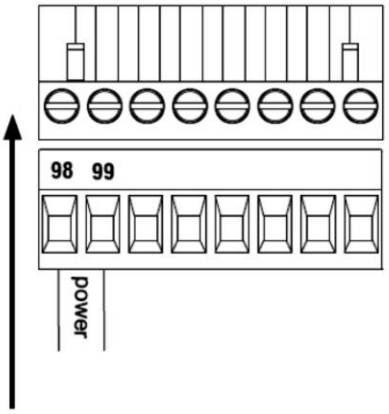
With regards to the modular loading affect, maximum power for each is listed below:
1. RMCxxxxxxxxxxx @ 7 watts / 14VA
2. RMEx-xxxx-xxxx @ 7 watts / 14VA
3. RMAx-xxxx-xxxx @ 4 watts / 9VA
4. RMLx-xxxx-xxxx @ 7 watts / 14VA
5. RMHx-xxxx-xxxx @ 7 watts / 14VA
6. RMSx-xxxx-xxxx @ 7 watts / 14VA

So in the worst case EtherCAT® integrated system, 48 loops, the maximum current draw on the supply would be 39 watts.
- 1 RMZ4 consumes 4 watts
- 3 RMS modules consumes 21 watts
- 2 RME modules consumes 14 watts

5.3 SLOT C POWER CONNECTION

Low Power

RM - All Model Numbers



- 20.4 to 30.8VAC ~ (ac) / ⎓ (dc) 14VA
- 47 to 63Hz
- Controller module power consumption, 7 Watts maximum
- 31 Watts maximum power available for P/S part #:0847-0299-0000
- 60 Watts maximum power available for P/S part #:0847-0300-0000
- 91 Watts maximum power available for P/S part #:0847-0301-0000
- Class 2 or Safety Extra Low Voltage (SELV) power source required to meet UL® compliance standards

Power and Communications		
Slot C	**Terminal Function**	**Configuration**
98 99	Power Input: AC or DC+ Power Input: AC or DC-	Only needed on one module, shared on backplane
CF CD CE	Standard Bus EIA-485 Common Standard Bus EIA-485 T-/R- (A) Standard Bus EIA-485 T+/T+ (B)	EIA-485 connection for EZ-ZONE Configurator
CZ CX CY	Inter-module Bus Inter-module Bus Inter-module Bus	Wire for Split-Rail Configurations

5.4 EARTH GROUND

The RJ-45 connector bodies are grounded to earth using the wire traps found on the bottom of the case. To ground the connector, insert a ground wire into either of the traps as viewed from the case bottom. The ETG.5003 Semi Standard recommends grounding the jacket. Each jacket is connected to the terminal trap via a 50ohm resistor. This earth ground is not connected to the power.

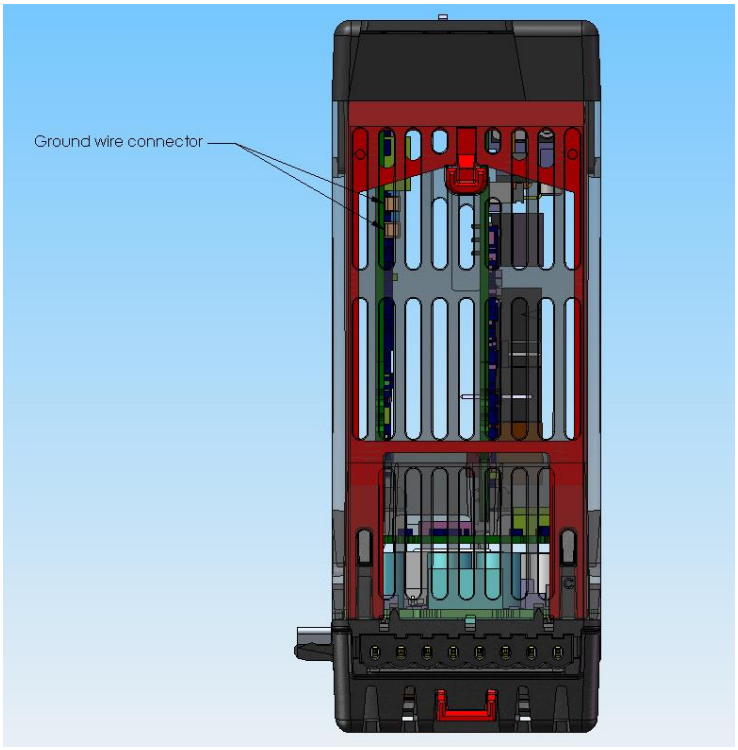


FIGURE 5 - GROUND WIRE LOCATION

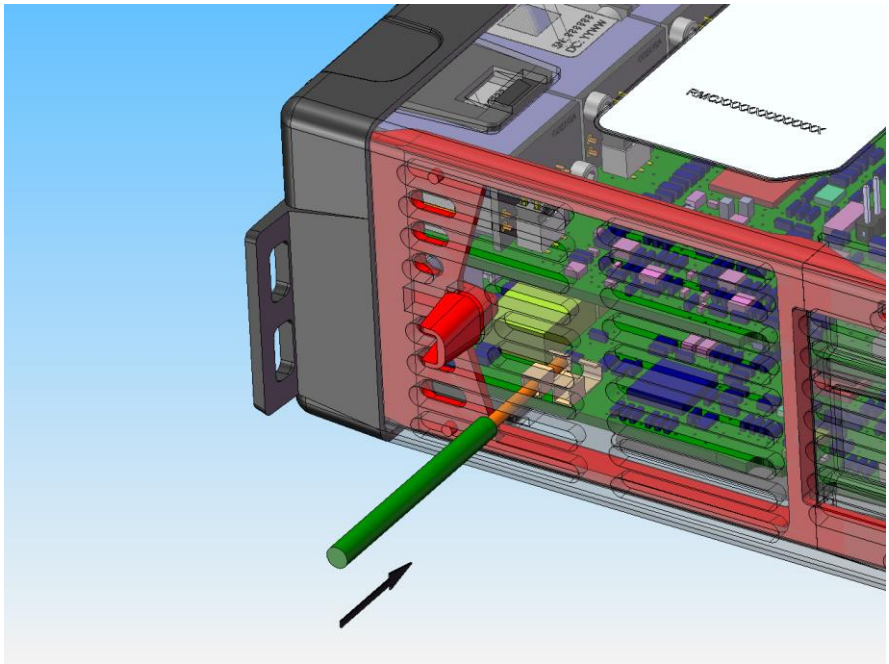
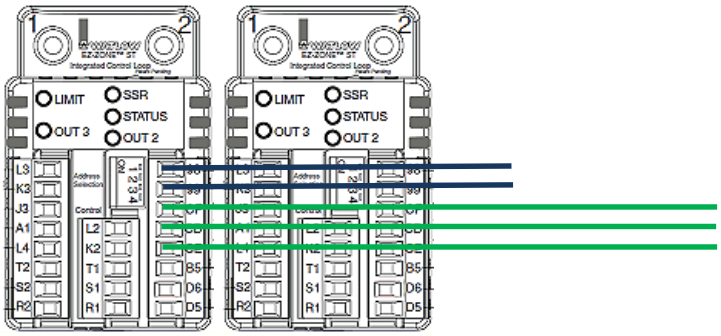


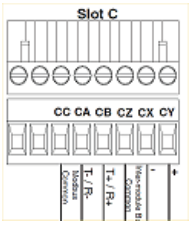
FIGURE 6 - GROUND WIRE INSERTION

Use 18 – 26 AWG Solid or Stranded, Trim Length 3.5 ± 0.5mm (0.138 ± .02”). Twist wire to remove.

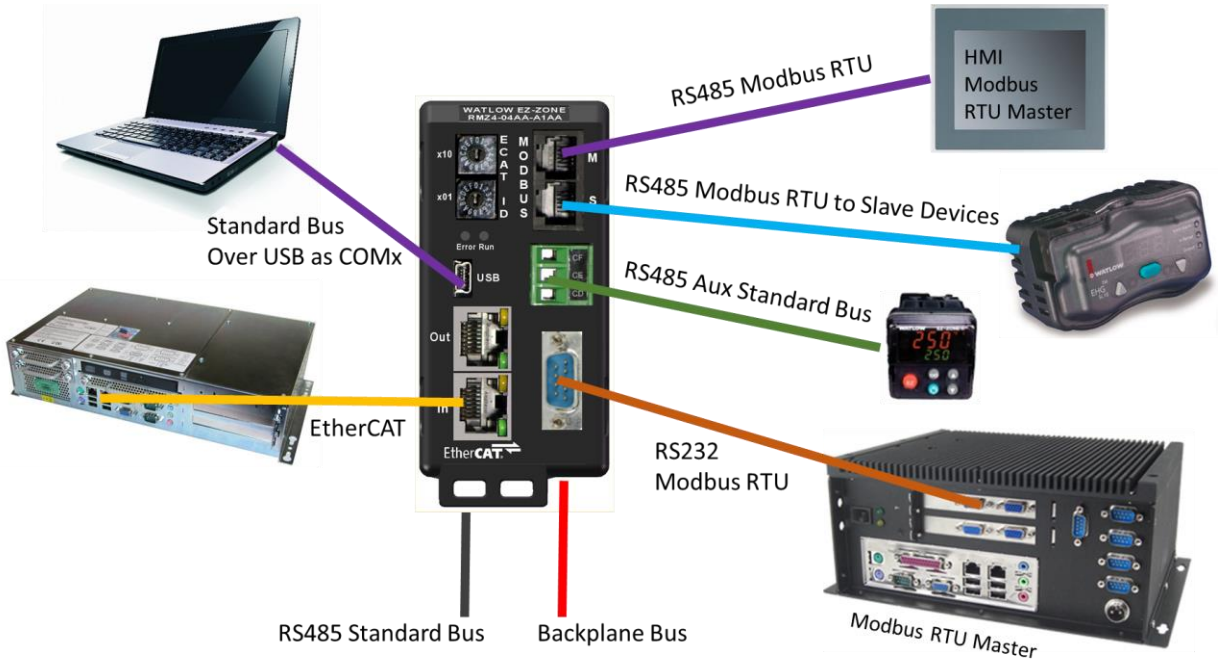
5.5 EZ-ZONE ST AND EZ-ZONE PM WIRING

Connect EZ-ZONE STs or PMs via the CF (Com), CD(A-), and CE(B+) terminals on the Slot “C” connector. This is the RS-485 Standard Bus connection. The RMZ4 will recognize these devices automatically. View and confirm discovered devices using the 0xF500 objects.





5.6 DEVICE WIRING



5.7 EtherCAT® Wiring on RJ-45

EtherCAT® uses standard CAT5 or CAT6 Ethernet cable. The network is wired device to device in series. Connect a cable from the EtherCAT® master or an upstream device to the IN RJ-45 port. If there are additional EtherCAT® devices on the network connect the OUT jack to those. If there are none, leave the jack empty.

5.8 DeviceNet Wiring on M12

5.9 USB Wiring

Connect a USB mini cable from a PC to configure RM features that are outside the EtherCAT® specification. These could be function blocks such as Logic or Compare blocks. Use the EZ-ZONE Configurator software to connect via the USB port. All the RM devices in the system should appear when the network is scanned. Use the **Watlow_USB.inf** driver located on watlow.com to create a USB serial port on your PC.

5.10 Modbus® RTU RS-485 Wiring RJ-12 Master or Slave

If the RMZ4 has the optional Legacy Communications card, it can be connected to simple Modbus® temperature controllers and act as a master using the Modbus M port. It can also be connected to graphical HMIs such as Watlow Silver Series to display system information using the Modbus S port. These are both RS-485 connections on RJ-12 phone jacks.

The Modbus register table is defined in a supporting spreadsheet **RmzParameterMap.xlsx** available on watlow.com.

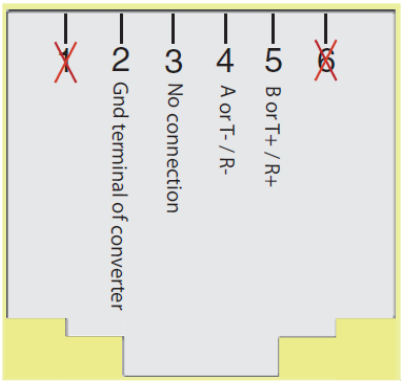


FIGURE 7 – MODBUS® MASTER AND SLAVE RJ-12 CONNECTOR PINOUT

5.1 MODBUS® RTU RS-232 WIRING ON DB9

6 THEORY OF OPERATION

EtherCAT® is a protocol that runs on standard Ethernet hardware – CAT5 cable, RJ45 jacks and standard physical layer transceivers. The Ethernet Media Access Controller (MAC) is a slight variation of a standard MAC implemented with an ASIC. It allows data to be read and modified on-the-fly as the bits pass through the MAC. This implies EtherCAT® is a ring topology with each device being part of a single chain. Data frames are not received and responses formulated. It is more like a train of bytes that does not slow down at the station, data jumps on and off as the 'train' passes though. This allows cycle times around the network in the microsecond range, even with thousands of data points. This is the PDO (Process Data Object – real-time data) mechanism.

Responsiveness is very important in a large system to keep scan times short. This means products should not introduce latencies in the system's data cycle. Therefore the data of interest to the larger system must be maintained close to the EtherCAT® access port. It is not acceptable to have long latencies while data is retrieved via the backplane. To assure the required speed, the EZ-ZONE architecture has been modified slightly to maintain critical data objects in the EtherCAT® module itself rather than each RM module.

EtherCAT® models data as CoE objects. CoE is CANOpen over EtherCAT®. This is the object model developed for the CAN Open protocol and reused as the EtherCAT data model. It uses objects defined by indexes (0x0000 to 0xFFFF) each containing up to 255 sub-indexes or data elements of simple or complex data type.

EtherCAT® transports data using PDO and SDO methods. PDO is Process Data Object. It is the regular data shared to and from the master to all the slave devices. The network PDO scan times are very fast, 0.5 to 4ms typically. The data in the PDO is a selected set of Object:SubIndex parameters. Typical PDO parameters are process temperature, set point, output power, and errors. PDO data is only exchanged when the system is in the operational mode (OP mode). As a default, the RMZ4 controller only controls temperature in the operational mode. The Safe State parameter configures this behavior.

SDO is Service Data Object. This is an asynchronous, on-demand mailbox service that provides access to all the CoE objects in the device. The SDO method is used to configure the device or tweak settings. Setting PID, Proportional Integral Derivative control loop parameters or starting an auto-tune would be typical uses for an exchange. SDO exchanges can occur during normal operation but are secondary to PDO traffic. SDO exchanges can occur in all modes except boot mode.

The EtherCAT® module holds all the data that is part of the Semi TWG (Technical Working Group) Standard for all the loops being controlled locally in the EtherCAT® module. The control loops are hosted by the EtherCAT® module. The EtherCAT® module works in conjunction with RM modules to act as sensor inputs and heater outputs only. The PV (Process Value Temperature) is produced by an RM and consumed by the EtherCAT® module via data sharing. The loop power is produced by the EtherCAT® module and consumed by an RM output via data sharing. The values accessed by the EtherCAT® module are the values held internally. This includes PV, SP (Set Point), PID values, control mode, percent power, etc.

In legacy product configurations (ST,PM,SL-10) the pertinent data is held locally within the EtherCAT® adapter for instant access but the control loops still execute in the individual devices due to the lower bandwidth

buses. There means parameter changes made over EtherCAT® can take up to 200ms to be written to the remote legacy device since they need to be sent by proxy on the legacy communications bus. Input values are continuously scanned by the RMZ4 and the latest value is available for PDO access.

Some configuration data such as sensor type, cycle time, input and output scaling are considered configuration data by EtherCAT®. It is not part of the EtherCAT®'s fast I/O cycle. These values are written out to each of the RM modules on power-up or value change to ensure the I/O configuration matches the SDO values. Local copies in the EtherCAT® module are maintained for immediate access even though a proxy write is required on change. The configuration values changed will take effect within 200ms.

The RMZ4 models individual control loops as modules or slots as described by the EtherCAT® Modular Device Profile. Each control loop is mapped to a module or slot. This is a logical association. The EtherCAT® loop module does not map one to one with physical RM modules. The configuration section describes how to map the I/O in each RM physical module with the appropriate control loop. Any of the RM family with IO may be used in conjunction with the RMZ. This includes RMC, RMH, RMS, RML, and RME.

Details and specifications for EtherCAT® are available at: http://www.ethercat.org/

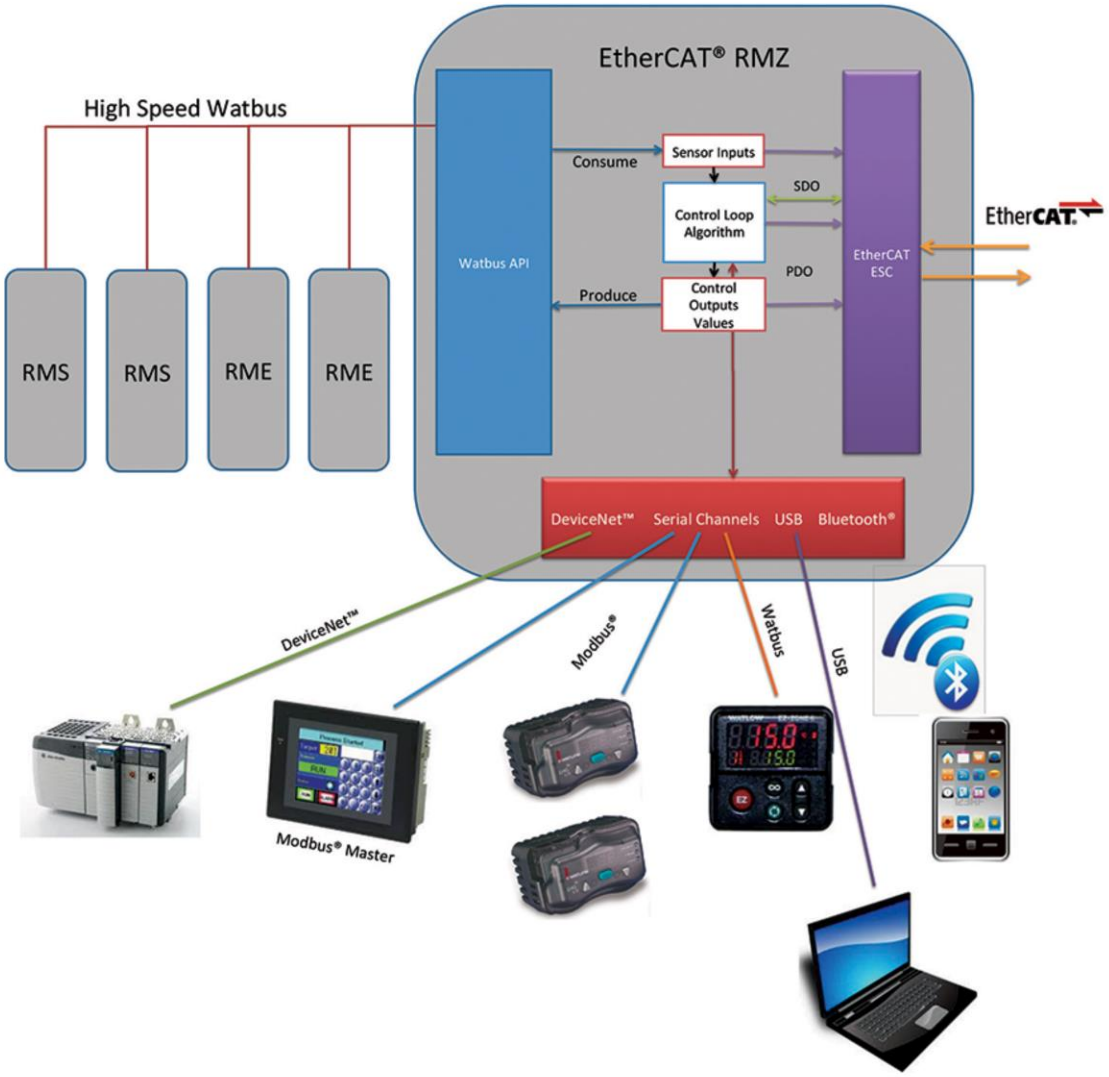


FIGURE 8 – CONNECTIONS AND TOPOLOGY

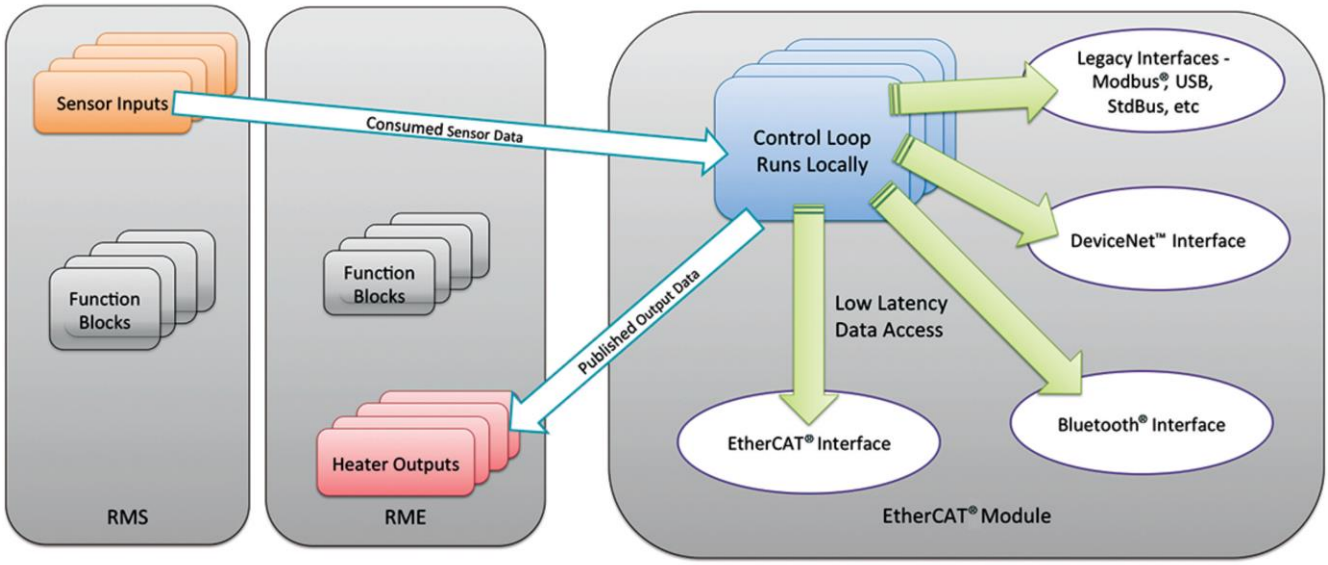


FIGURE 9 – RM CONTROL LOOP TOPOLOGY

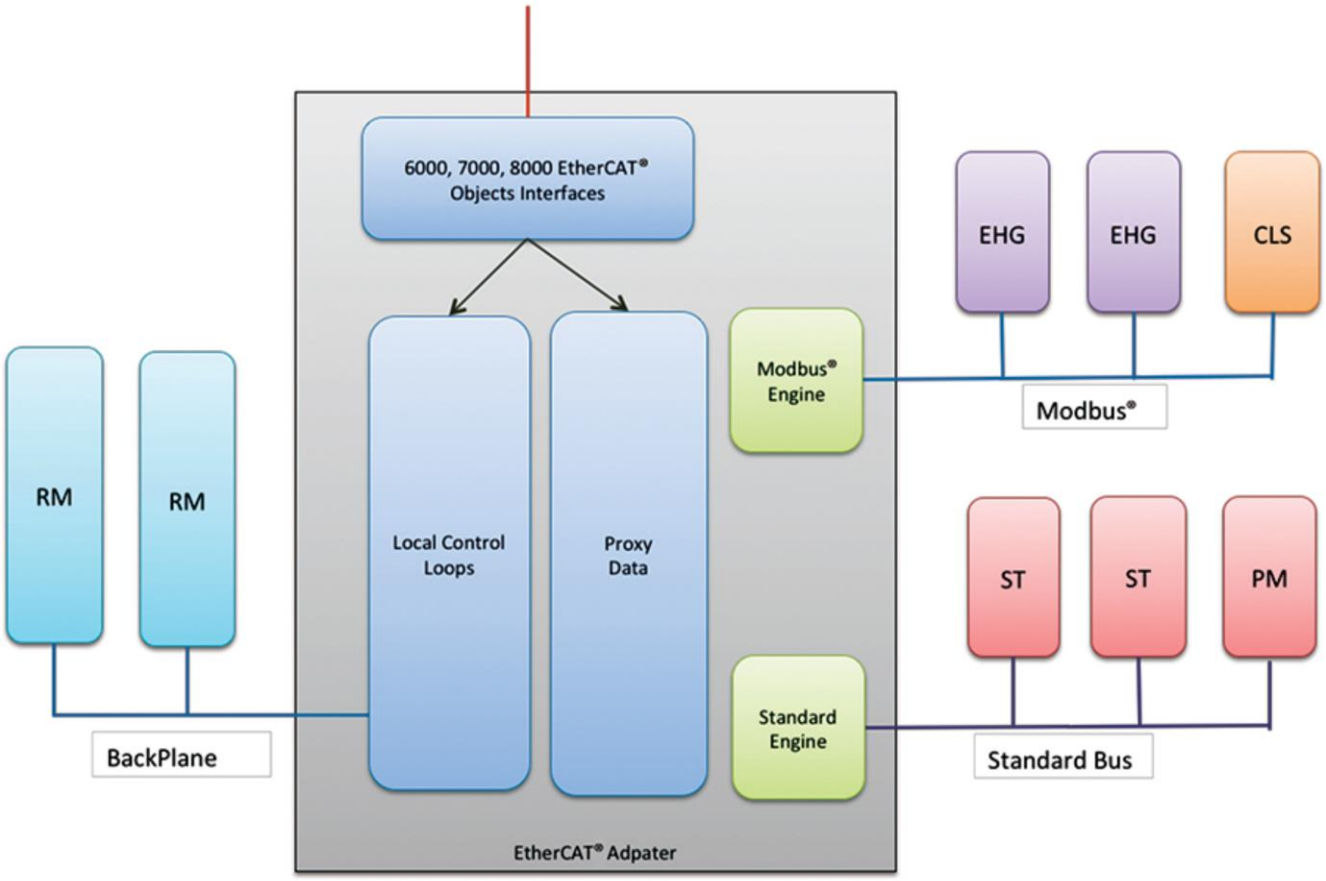


FIGURE 10 – COMPLETE NETWORK INTERACTION DIAGRAM

7 SETTING UP THE SYSTEM

7.1 STEPS TO IMPLEMENT WITH ETHERCAT

1. Mount controllers
2. Wire power, sensors and outputs to heaters
3. Wire CAT5/6 cable to EtherCAT® jacks
4. Set explicit Device ID if needed
5. Verify RM module addresses are set correctly
6. Install Master Software
7. Import the ESI for the RMZ, **Watlow_RMZ.xml** into the master software.
8. Connect to RMZ4 from Master
9. Configure module/slots for loops needed
10. Setup I/O mapping in 0x4nn0 objects
11. Configure device with 0x4nn1 and 0x8nn0 objects
12. Configure any user specific PDO data beyond the default set
13. Change mode to operational.
14. Program Set Point and Control State in output PDO
15. Monitor system with input PDO

7.2 ETHERCAT® MASTER AND ESI FILE

EtherCAT® systems have a master that configures the network and the devices then manages data interactions with the devices during operation. Beckhoff®'s TwinCAT® or EtherCAT® Configurator are common master software programs that run on a standard 32 bit Windows® PC. The Master needs an ESI file to describe the device and its capabilities. This file is in XML format and provided by Watlow for the RMZ. The ESI file contains the object dictionary for the RMZ. There is one ESI file regardless of the version of RMZ that contains the parameter details for all product versions. The master will select the correct version from the ESI based on the version information reported from the RMZ. If a new version produce is added to the system make sure to have the master reload the correct definition from the latest ESI file.

7.3 MASTER INSTRUCTIONS

- Under I/O Device right click and Scan for Device
- Scan for Boxes answer Yes
- Start Free Run - Yes
- You should see Box 1 (Watlow RM)
- We need to add a Module for each control loop by right clicking Append Module
- Add the correct number of control loops
- Reload Configuration to the RMs under Action

7.4 EXPLICIT DEVICE IDENTIFICATION

Use the two rotary address switches to set the devices Explicit Device ID. The 0x10 switch sets the upper nibble and 0x01 sets the lower nibble of the unique ID value. This is available over EtherCAT® in register 0x134. This allows absolute, unique identification of each device in the system.

7.5 Mapping Loop to CoE Object Indexes

The RMZ4 supports up to 48 loops. The EtherCAT® module slots map to the control loops as defined in this table.

Loop	Watlow Outputs	Watlow Outputs	I/O Mapping	Configuration	Inputs	Outputs	Setup	TxPDO	RxPDO	User TxPDO	User RxPDO
1	0x2000	0x3000	0x4000	0x4001	0x6000	0x7000	0x8000	0x1600	0x1A00	0x1601	0x1A01
2	0x2010	0x3010	0x4010	0x4011	0x6010	0x7010	0x8010	0x1602	0x1A02	0x1603	0x1A03
3	0x2020	0x3020	0x4020	0x4021	0x6020	0x7020	0x8020	0x1604	0x1A04	0x1605	0x1A05
4	0x2030	0x3030	0x4030	0x4031	0x6030	0x7030	0x8030	0x1606	0x1A06	0x1607	0x1A07
5	0x2040	0x3040	0x4040	0x4041	0x6040	0x7040	0x8040	0x1608	0x1A08	0x1609	0x1A09
6	0x2050	0x3050	0x4050	0x4051	0x6050	0x7050	0x8050	0x160A	0x1A0A	0x160B	0x1A0B
7	0x2060	0x3060	0x4060	0x4061	0x6060	0x7060	0x8060	0x160C	0x1A0C	0x160D	0x1A0D
8	0x2070	0x3070	0x4070	0x4071	0x6070	0x7070	0x8070	0x160E	0x1A0E	0x160F	0x1A0F
9	0x2080	0x3080	0x4080	0x4081	0x6080	0x7080	0x8080	0x1610	0x1A10	0x1611	0x1A11
10	0x2090	0x3090	0x4090	0x4091	0x6090	0x7090	0x8090	0x1612	0x1A12	0x1613	0x1A13
11	0x20A0	0x30A0	0x40A0	0x40A1	0x60A0	0x70A0	0x80A0	0x1614	0x1A14	0x1615	0x1A15
12	0x20B0	0x30B0	0x40B0	0x40B1	0x60B0	0x70B0	0x80B0	0x1616	0x1A16	0x1617	0x1A17
13	0x20C0	0x30C0	0x40C0	0x40C1	0x60C0	0x70C0	0x80C0	0x1618	0x1A18	0x1619	0x1A19
14	0x20D0	0x30D0	0x40D0	0x40D1	0x60D0	0x70D0	0x80D0	0x161A	0x1A1A	0x161B	0x1A1B
15	0x20E0	0x30E0	0x40E0	0x40E1	0x60E0	0x70E0	0x80E0	0x161C	0x1A1C	0x161D	0x1A1D
16	0x20F0	0x30F0	0x40F0	0x40F1	0x60F0	0x70F0	0x80F0	0x161E	0x1A1E	0x161F	0x1A1F
17	0x2100	0x3100	0x4100	0x4101	0x6100	0x7100	0x8100	0x1620	0x1A20	0x1621	0x1A21
18	0x2110	0x3110	0x4110	0x4111	0x6110	0x7110	0x8110	0x1622	0x1A22	0x1623	0x1A23
19	0x2120	0x3120	0x4120	0x4121	0x6120	0x7120	0x8120	0x1624	0x1A24	0x1625	0x1A25
20	0x2130	0x3130	0x4130	0x4131	0x6130	0x7130	0x8130	0x1626	0x1A26	0x1627	0x1A27
21	0x2140	0x3140	0x4140	0x4141	0x6140	0x7140	0x8140	0x1628	0x1A28	0x1629	0x1A29
22	0x2150	0x3150	0x4150	0x4151	0x6150	0x7150	0x8150	0x162A	0x1A2A	0x162B	0x1A2B
23	0x2160	0x3160	0x4160	0x4161	0x6160	0x7160	0x8160	0x162C	0x1A2C	0x162D	0x1A2D
24	0x2170	0x3170	0x4170	0x4171	0x6170	0x7170	0x8170	0x162E	0x1A2E	0x162F	0x1A2F
25	0x2180	0x3180	0x4180	0x4181	0x6180	0x7180	0x8180	0x1630	0x1A30	0x1631	0x1A31
26	0x2190	0x3190	0x4190	0x4191	0x6190	0x7190	0x8190	0x1632	0x1A32	0x1633	0x1A33
27	0x21A0	0x31A0	0x41A0	0x41A1	0x61A0	0x71A0	0x81A0	0x1634	0x1A34	0x1635	0x1A35
28	0x21B0	0x31B0	0x41B0	0x41B1	0x61B0	0x71B0	0x81B0	0x1636	0x1A36	0x1637	0x1A37
29	0x21C0	0x31C0	0x41C0	0x41C1	0x61C0	0x71C0	0x81C0	0x1638	0x1A38	0x1639	0x1A39
30	0x21D0	0x31D0	0x41D0	0x41D1	0x61D0	0x71D0	0x81D0	0x163A	0x1A3A	0x163B	0x1A3B
31	0x21E0	0x31E0	0x41E0	0x41E1	0x61E0	0x71E0	0x81E0	0x163C	0x1A3C	0x163D	0x1A3D
32	0x21F0	0x31F0	0x41F0	0x41F1	0x61F0	0x71F0	0x81F0	0x163E	0x1A3E	0x163F	0x1A3F
33	0x2200	0x3200	0x4200	0x4201	0x6200	0x7200	0x8200	0x1640	0x1A40	0x1641	0x1A41
34	0x2210	0x3210	0x4210	0x4211	0x6210	0x7210	0x8210	0x1642	0x1A42	0x1643	0x1A43
35	0x2220	0x3220	0x4220	0x4221	0x6220	0x7220	0x8220	0x1644	0x1A44	0x1645	0x1A45
36	0x2230	0x3230	0x4230	0x4231	0x6230	0x7230	0x8230	0x1646	0x1A46	0x1647	0x1A47
37	0x2240	0x3240	0x4240	0x4241	0x6240	0x7240	0x8240	0x1648	0x1A48	0x1649	0x1A49
38	0x2250	0x3250	0x4250	0x4251	0x6250	0x7250	0x8250	0x164A	0x1A4A	0x164B	0x1A4B
39	0x2260	0x3260	0x4260	0x4261	0x6260	0x7260	0x8260	0x164C	0x1A4C	0x164D	0x1A4D
40	0x2270	0x3270	0x4270	0x4271	0x6270	0x7270	0x8270	0x164E	0x1A4E	0x164F	0x1A4F
41	0x2280	0x3280	0x4280	0x4281	0x6280	0x7280	0x8280	0x1650	0x1A50	0x1651	0x1A51
42	0x2290	0x3290	0x4290	0x4291	0x6290	0x7290	0x8290	0x1652	0x1A52	0x1653	0x1A53
43	0x22A0	0x32A0	0x42A0	0x42A1	0x62A0	0x72A0	0x82A0	0x1654	0x1A54	0x1655	0x1A55
44	0x22B0	0x32B0	0x42B0	0x42B1	0x62B0	0x72B0	0x82B0	0x1656	0x1A56	0x1657	0x1A57
45	0x22C0	0x32C0	0x42C0	0x42C1	0x62C0	0x72C0	0x82C0	0x1658	0x1A58	0x1659	0x1A59
46	0x22D0	0x32D0	0x42D0	0x42D1	0x62D0	0x72D0	0x82D0	0x165A	0x1A5A	0x165B	0x1A5B
47	0x22E0	0x32E0	0x42E0	0x42E1	0x62E0	0x72E0	0x82E0	0x165C	0x1A5C	0x165D	0x1A5D
48	0x22F0	0x32F0	0x42F0	0x42F1	0x62F0	0x72F0	0x82F0	0x165E	0x1A5E	0x165F	0x1A5F

FIGURE 11 – MODULAR LOOP LAYOUT

7.6 SETUP FOR DEVICENET

DeviceNet uses the same CAN OPEN data model as EtherCAT. The DeviceNet classes map to the objects per this table.

Object	EtherCAT Index	DeviceNet Class		
Device	0x1000	0x64		
Watlow Inputs	0x2nn0	0x65	T2O Element	
Watlow Output	0x3nn0	0x66	O2T Element	
Watlow Mapping	0x4nn0	0x67		
Watlow Setup	0x4nn1	0x68		
Alarm Group	0x5F00	0x69		
Alarm Picks	0x5F00	0x6A		
Inputs	0x6nn0	0x6B	T2O Element	
Outputs	0x7nn0	0x6C	O2T Element	
Setup	0x8nn0	0x6D		
Optic Sensor	0x0	0x6E		
Optic Calibration	0x0	0x6F		
PDO Input/O2T Implicit User Setup	0x1A00	0x70	T2O Setup	
PDO Output/T2O Implicit Setup	0x1C00	0x71	O2T Setup	
O2T Data via Explicit	0x	0x72	T2O Data	
T2O Data via Explicit	0x	0x73	O2T Data	

The DeviceNet Attributes are the same as the EtherCAT SubIndex. The DeviceNet instance in the Module Slot offset from EtherCAT. For example 0x6nn0 is instance nn over DeviceNet.

7.7 DEVICENET IMPLICIT DATA

The implicit data, like the EtherCAT PDO is

Implicit Inputs Class 0x70	Attribute 0x01	Attribute 0x02	Attribute 0x03
Entry 1	Class ID	Attribute ID	Instance
Entry 2	Class ID	Attribute ID	Instance
Entry n	Class ID	Attribute ID	Instance

Implicit Outputs Class 0x71	Attribute 0x01	Attribute 0x02	Attribute 0x03
Entry 1	Class ID	Attribute ID	Instance
Entry 2	Class ID	Attribute ID	Instance
Entry n	Class ID	Attribute ID	Instance

7.8 CONFIGURING THE RMZ4

The I/O in the EtherCAT® system uses RZ-ZONE RMS, RMH, and RMC modules for sensor inputs and RME, RMS, or RMC modules for heater outputs. The RMZ4 module performs the actual control algorithms. The controls loops are mapped to the I/O modules in the same manner regardless of the loop count. Limits implemented in the RML are still maintained in the RML module but configured via the EtherCAT® interface. The number of

loops in the system is defined by the part number. Each control loop in the object ranges (0x4000, 0x6000, 0x7000 and 0x8000) is offset by 0x10 as show in the table is section 6.5. The RMZ4 is a Modular EtherCAT® device. When using TwinCAT® Master software to add each control loop to your master configuration, add additional control loop slots under “Box 1 (Watlow RM): Append Module.” The loops are connected to I/O using the 0x4000 range of objects. The RMZ4 can also be used with EZ-ZONE ST as an interface to these stand-alone controllers. The data is presented to the network with the same model.

7.9 IDENTIFYING THE RMZ4 ITSELF

The identity of the RMZ4 module is accessed through objects 0x1000.

7.10 SETTING ADDRESSES ON CONNECTED DEVICES

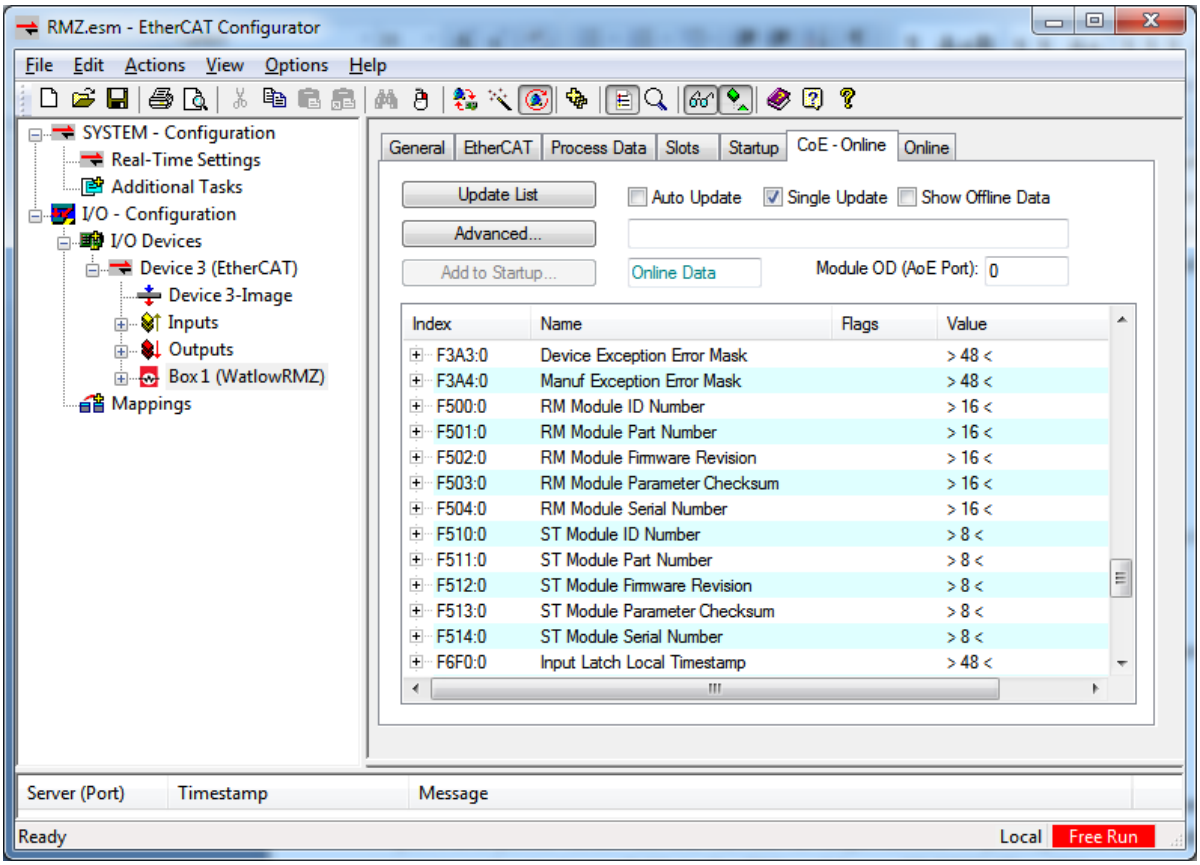
Each EZ-ZONE RMS, RME, RML, RMF, RMC, or RMH device needs a unique address to identify it on the bus. This is the orange digit in the upper right hand side of the device. To change, hold the orange button until the digit glows brightly then press to increment by 1; the value will wrap around to 1. Make sure each device has a unique value.

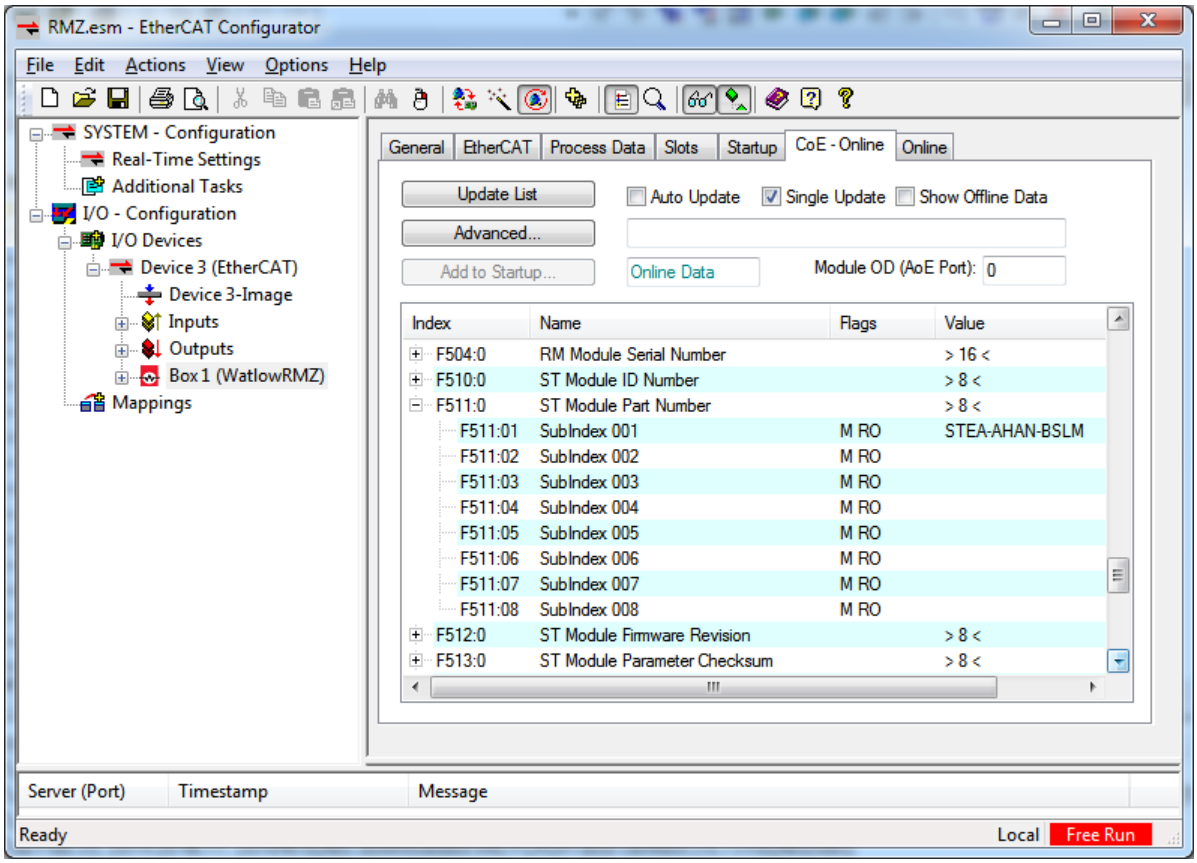
The DIP switches on the front of the EZ-ZONE ST devices set the device’s zone. If the system contains both RM and ST devices, they all need to have unique addresses because they share the standard bus address space.

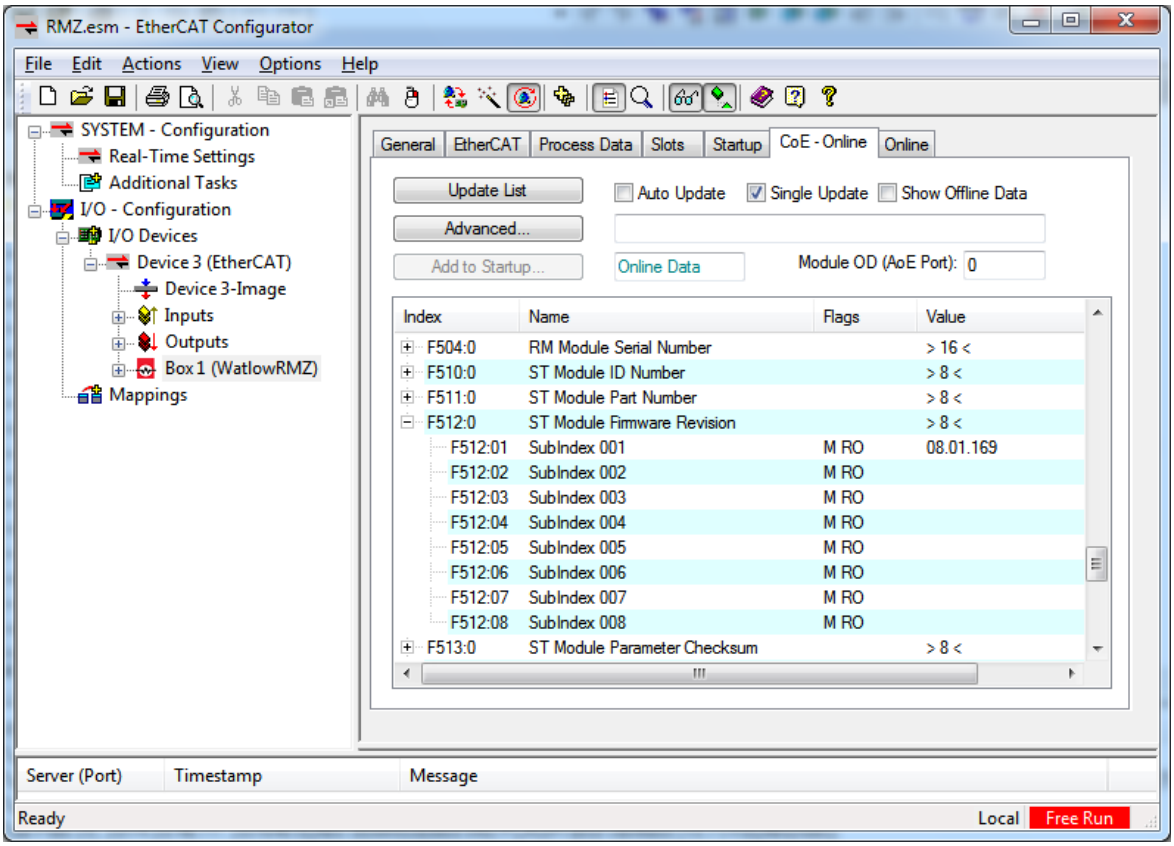
This is the Zone Number used to map I/O in the 0x4000 objects.

7.11 IDENTIFYING CONNECTED DEVICES

The RM modules connected to the RMZ4 via the backplane or split-rail are visible in objects 0xF500 to 0xF504. The ST or PM modules connected to the RMZ4 via the Standard Bus connection are visible in objects 0xF510 to 0xF514. The products ID, part number, revision, and serial number may be observed.


RMZ.esm - EtherCAT Configurator
File Edit Actions View Options Help
SYSTEM - Configuration
Real-Time Settings
Additional Tasks
I/O - Configuration
I/O Devices
Device 3 (EtherCAT)
Device 3-Image
Inputs
Outputs
Box 1 (WatlowRMZ)
Mappings
General EtherCAT Process Data Slots Startup CoE - Online Online
Update List
Auto Update
Single Update
Show Offline Data
Advanced...
Add to Startup...
Online Data
Module OD (AoE Port): 0
Index Name Flags Value
F3A3:0 Device Exception Error Mask > 48 <
F3A4:0 Manuf Exception Error Mask > 48 <
F500:0 RM Module ID Number > 16 <
F501:0 RM Module Part Number > 16 <
F502:0 RM Module Firmware Revision > 16 <
F503:0 RM Module Parameter Checksum > 16 <
F504:0 RM Module Serial Number > 16 <
F510:0 ST Module ID Number > 8 <
F511:0 ST Module Part Number > 8 <
F512:0 ST Module Firmware Revision > 8 <
F513:0 ST Module Parameter Checksum > 8 <
F514:0 ST Module Serial Number > 8 <
F6F0:0 Input Latch Local Timestamp > 48 <
Server (Port) Timestamp Message
Ready
Local
Free Run


RMZ.esm - EtherCAT Configurator
File Edit Actions View Options Help
SYSTEM - Configuration
Real-Time Settings
Additional Tasks
I/O - Configuration
I/O Devices
Device 3 (EtherCAT)
Device 3-Image
Inputs
Outputs
Box 1 (WatlowRMZ)
Mappings
General EtherCAT Process Data Slots Startup CoE - Online Online
Update List
Auto Update
Single Update
Show Offline Data
Advanced...
Add to Startup...
Online Data
Module OD (AoE Port): 0
Index Name Flags Value
F504:0 RM Module Serial Number > 16 <
F510:0 ST Module ID Number > 8 <
F511:0 ST Module Part Number > 8 <
F511:01 SubIndex 001 M RO STEA-AHAN-BSLM
F511:02 SubIndex 002 M RO
F511:03 SubIndex 003 M RO
F511:04 SubIndex 004 M RO
F511:05 SubIndex 005 M RO
F511:06 SubIndex 006 M RO
F511:07 SubIndex 007 M RO
F511:08 SubIndex 008 M RO
F512:0 ST Module Firmware Revision > 8 <
F513:0 ST Module Parameter Checksum > 8 <
Server (Port) Timestamp Message
Ready
Local
Free Run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Box 1 (WatlowRMZ)
Mappings
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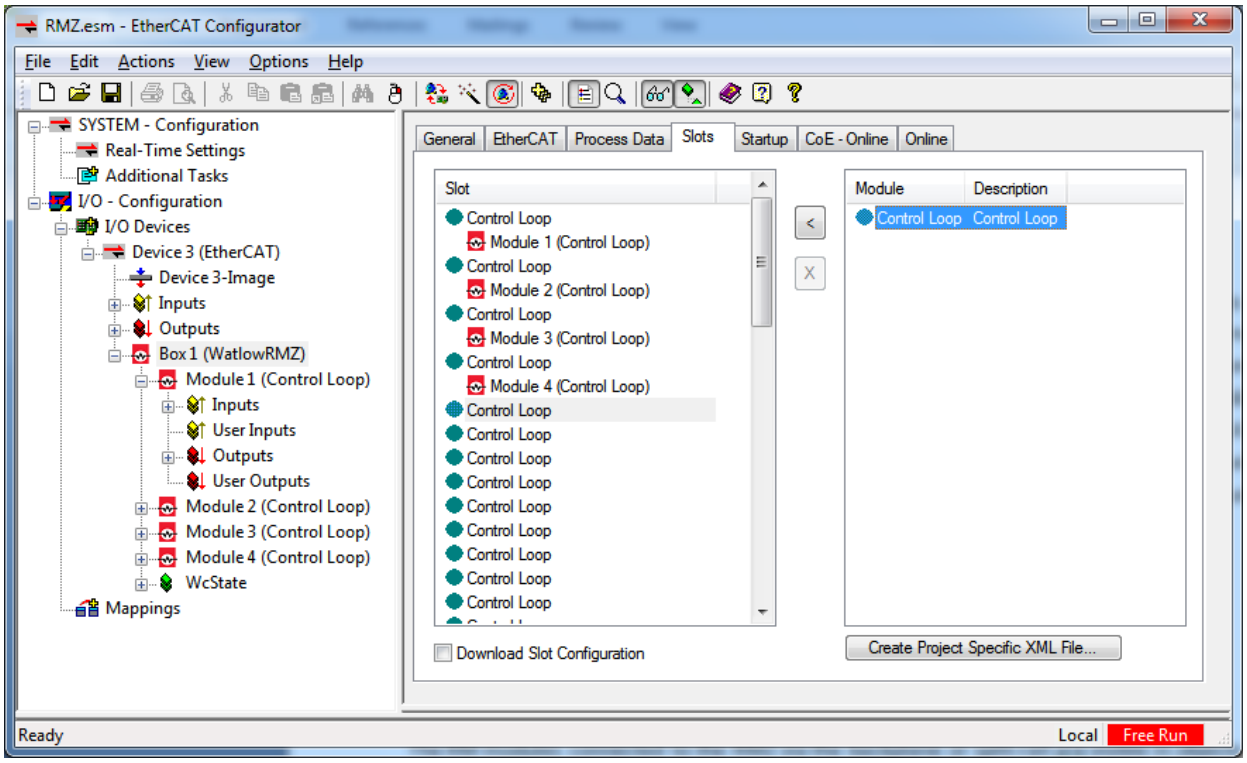
Update List
Auto Update
Single Update
Show Offline Data
Advanced...
Add to Startup...
Online Data
Module OD (AoE Port): 0
Index Name Flags Value
F504:0 RM Module Serial Number > 16 <
F510:0 ST Module ID Number > 8 <
F511:0 ST Module Part Number > 8 <
F512:0 ST Module Firmware Revision > 8 <
F512:01 SubIndex 001 M RO 08.01.169
F512:02 SubIndex 002 M RO
F512:03 SubIndex 003 M RO
F512:04 SubIndex 004 M RO
F512:05 SubIndex 005 M RO
F512:06 SubIndex 006 M RO
F512:07 SubIndex 007 M RO
F512:08 SubIndex 008 M RO
F513:0 ST Module Parameter Checksum > 8 <
Server (Port) Timestamp Message
Ready
Local
Free Run

7.12 ADDING SLOTS

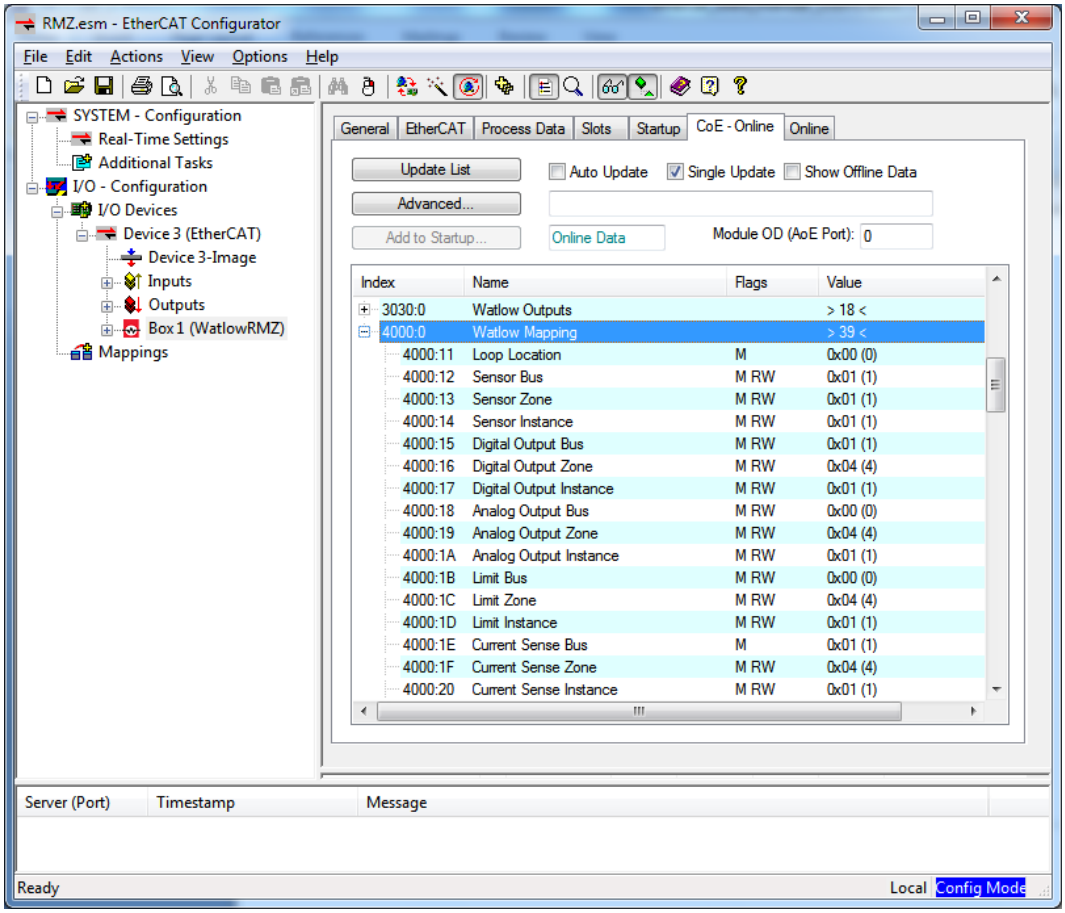
A slot is a logical organization of modular control loops. Each slot or loop represents a sensor, PID loop, set point and power level. Add the number of loops needed in your system. Once added, loops are mapped to the inputs, output, limits, current sensor, and over-temp limits available in the RM modules or EZ-ZONE ST or PM. Typically a system will use and RMS for input and an RME for outputs and current transformers. This system can be augmented with an RML limits module for over-temp protection. If the system has few loops an RMC is an option for integrating sensor, outputs, limits and CT is one hardware module. The 0x4000 objects are used to define the I/O location for each loop. The maximum number of slots/control loops the user can add is defined in the module number. RMZ4-**nn**AA-AAAA where **nn** is the maximum number of loops that can be added.



7.13 MAPPING I/O TO LOOPS (SLOTS)

The 0x4000 objects define the connection between the RMZ4 control loops and the system I/O. Each loop has a configuration object offset by 0x10 like all modular objects. Each of the control loops needs to be associated with I/O in the attached EZ-ZONE RM or ST modules.

Important: The default mapping is loop sensor inputs 1 to 16 map to zone 1 instances 1 to 16. Digital outputs map to zone 2, DIO instance 1 to 16. This may not match your system. Make sure to verify all mapping points and set unmapped elements to bus 0 (unused) to ensure proper operation. Send the Save Non-Volatile Command to ensure the mapping is maintained.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Device 3 (EtherCAT)
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Mappings
General EtherCAT Process Data Slots Startup CoE - Online Online
Update List
Auto Update
Single Update
Show Offline Data
Advanced...
Add to Startup...
Online Data
Module OD (AoE Port): 0
Index Name Flags Value
3030:0 Watlow Outputs > 18 <
4000:0 Watlow Mapping > 39 <
4000:11 Loop Location M 0x00 (0)
4000:12 Sensor Bus M RW 0x01 (1)
4000:13 Sensor Zone M RW 0x01 (1)
4000:14 Sensor Instance M RW 0x01 (1)
4000:15 Digital Output Bus M RW 0x01 (1)
4000:16 Digital Output Zone M RW 0x04 (4)
4000:17 Digital Output Instance M RW 0x01 (1)
4000:18 Analog Output Bus M RW 0x00 (0)
4000:19 Analog Output Zone M RW 0x04 (4)
4000:1A Analog Output Instance M RW 0x01 (1)
4000:1B Limit Bus M RW 0x00 (0)
4000:1C Limit Zone M RW 0x04 (4)
4000:1D Limit Instance M RW 0x01 (1)
4000:1E Current Sense Bus M 0x01 (1)
4000:1F Current Sense Zone M RW 0x04 (4)
4000:20 Current Sense Instance M RW 0x01 (1)
Server (Port) Timestamp Message
Ready
Local Config Mode

Bus Designators:

Bus #	Bus	Loop Location	Sensor	Outputs	Current	Limits
0	None	Not Active	Yes	Yes	Yes	Yes
1	RM Backplane / Split-Rail	Internal RMZ	Yes	Yes	Yes	Yes
2	EZ-ZONE ST or PM	External Device	Yes	Yes	Yes	Yes
3	EHG SL-10 Modbus	External Device	Yes	Yes	No	No
4	Fiber Optic Sensor	Internal RMZ	Yes	No	No	No
5	Remote Loop PV (written via EtherCAT)	Internal RMZ	Yes	No	No	No

8 USING CONTROLLER FEATURES

8.1 SENSOR AND CONTROL LOOP

Mapping

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Loop Location	0x4nn0	0x67	0x11	**I**ndicates if the loop is hosted locally (0) or remotely (1). If the sensor is mapped to the RM bus or optical inputs or Remote PV then loops are locally executed in the RMZ4 modules. If the sensors are in the ST, PM, SL-10, or CLS then the loops are remote since those devices are fully integrated controllers.
Sensor Bus	0x4nn0	0x67	0x12	Defines the bus the loop uses for the control sensor. 0 = Unused 1 = RM 2 = Legacy ST/PM 3 = Modbus 4 = Internal Optical Sensor Card 5 = Remote PV from 0x3000:0x13
Sensor Zone	0x4nn0	0x67	0x13	Defines which zone or address that is hosting this sensor input. For EZ-ZONE products it is the zone number displayed on the front. For EHG SL-10 it is the Modbus address. Optical sensors 1-4 are local in the RMZ4 so this value does not have meaning. Independent RMF optical modules are considered sensor type 1 – on the backplane.
Sensor Instance	0x4nn0	0x67	0x14	Defines which sensor instance on a particular zone for devices that have multiple inputs. For instance, an RMS module can have 16 TC inputs. To map to sensor 5 on RMS zone 3: Select Bus 2, Zone 3, Instance 5.

Configuring Sensor

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Sensor Type	0x8nn0	0x6D	0x11	Sets the input type to 0 = TC 1 = RTD100

				2 = RTD1000 3 =4-20mA 4 = 0-20mA 5 = 0-10V
Thermocouple Type	0x8nn0	0x6D	0x12	Sets the thermocouple type 0: K 1: J 2: T 3: E 4: N 5: R 6: S 7: B 8: C 9: D 10: F
RTD Lead Wires	0x4nn1	0x68	0x11	Sets the number of lead wires for RTD type inputs to 2 or 3 wires.
Input Calibration Offset/Bias	0x8nn0	0x6D	0x23	Allows the system to offset the input reading to compensate for system errors.
Process Scaling High	0x8nn0	0x6D	0x18	The process value corresponding to the high electric value for process input 10V or 20mA.
Process Scaling Low	0x8nn0	0x6D	0x19	The process value corresponding to the low electric value for process input 0V, 4mA, or 0mA.

Configuring Control Loop

Parameter	**ECAT Index**	**DNET Class**	**Sub /Attr**	**Description**
Heat Proportional Band	0x8nn0	0x6D	0x26	Sets the heat gain as a proportional band. Increase reduces gain and increases stability. Decreasing increases responsiveness.
Integral Time	0x8nn0	0x6D	0x27	Sets the rate the power increases or decreases. This will pull the temperature to set point. A low value integrates power quickly but can cause instability.
Derivative Time	0x8nn0	0x6D	0x28	Sets the derivative time constant. Reacts in opposition to changes in the process. Unless the system has significant lag, this value should be kept low or even zero.
Cool Algorithm	0x4nn1	0x68	0x12	Cooling action is Off, PID, or On/Off
Cool Proportional	0x8nn0	0x6D	0x29	The gain of the cooling part of the control loop. This is in effect if the cool mode is PID.
Cool Hysteresis	0x4nn1	0x68	0x13	If the cool mode is ON/OFF this is the switching hysteresis.
Dead Band	0x4nn1	0x68	0x2A	This is the space between the heating and the cooling regions to keep the system from oscillating continuously between heat and cool. It can also be set to a negative value so the

				heat and cooling actions will happen simultaneously in the band. This allows heat to modulate a less agile cooling system.
Ramp to Set Point Enable	0x4nn1	0x68	0x20	Enables set point ramping. If enabled, changes in set point will cause the actual set point to ramp from the current PV to the target SP at the programmed rate. 0 = Off 1 = Start Up 2 = Set Point Change 3 = Both
Ramp to Set Point Rate	0x4nn1	0x68	0x21	Defines the rate of set point ramping in degrees per minute.
Safe State Action	0x8nn0	0x6D	0x16	How the control operates in the Safe State. Loop Off (default), Manual, Standby Auto, or Nominally. 0 = Actual Control State (0x6nnn SI 0x01) = OFF 1 = Actual Control State (0x6nnn SI 0x01) = ON, Actual Control Mode (0x6nnn SI 0x02) = AUTO, Controlling Set Point (0x6nnn SI 0x16) = Target Set Point (0x7nnn SI 0x11) 2 = Actual Control State (0x6nnn SI 0x01) = ON, Actual Control Mode (0x6nnn SI 0x02) = AUTO, Controlling Set Point (0x6nnn SI 0x16)= Standby Set Point (0x8nnn SI 0x20) 3 = Actual Control State (0x6nnn SI 0x01) = ON, Actual Control Mode (0x6nnn SI 0x02) = MANUAL, Manipulated Value (0x6nnn 0x12) = Forced MV (0x7nnn SI 0x12) 4 = Operate as configured
Standby Set Point	0x8nn0	0x6D	0x20	Sets an alternate Set Point which way be used in the safe state to keep the system operational at a nominal set point.
Set Point High Limit	0x8nn0	0x6D	0x21	Defines the upper settable Target Set Point value. Use to ensure the set point is in an acceptable range.
Set Point Low Limit	0x8nn0	0x6D	0x22	Defines the lowest settable Target Set Point value. Use to ensure the set point is in an acceptable range.
MV High Limit	0x8nn0	0x6D	0x24	Defines the upper settable Forced MV value. Use to ensure the set manual power is in an acceptable range.

MV Low Limit	0x8nn0	0x6D	0x25	Defines the lowest settable Forced MV value. Use to ensure the manual power is in an acceptable range.

Using

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Process Sensor Value (PV)	0x6nn0	0x6B	0x11	The temperature process value reading of the sensor
Sensor Error	0x6nn0	0x6B	0x03	Indicates if the temperature reading is valid or has an error.
Target Set Point (SP)	0x7nn0	0x6C	0x11	Set the desired system temperature with this value.
Actual Controlling Set Point	0x6nn0	0x6B	0x16	The set point currently used for control. This may not be the target set point if the system is in the safe state or is ramping. This will show the current ramping set point when that feature is enabled.
Set Point is Ramping	0x2nn0	0x65	0x03	Indicates if the set point is ramping. This will not occur unless set point ramping is enabled.
Manipulated Value	0x6nn0	0x6B	0x12	The output of the control loop which manipulates the heater.
Heat Manipulated Value	0x6nn0	0x6B	0x13	The positive portion of the Manipulated Value which routes to heat outputs.
Cool Manipulated Value	0x6nn0	0x6B	0x14	The negative portion of the Manipulated Value which routes to cool outputs.
Forced Manipulated Value	0x7nn0	0x6C	0x12	This manual power directly drives the loop's output at this level when the loop's Control Mode is Manual. This is part of the default output PDO.
Desired Control State	0x7nn0	0x6C	0x01	Turns the control system on and off. Part of the default output PDO.
Actual Control State	0x6nn0	0x6B	0x01	Indicates if the control loop is on or off. In the safe state this will follow the state defined in the safe state parameter, typically off.
Desired Control Mode	0x7nn0	0x6C	0x02	Sets the control loop mode to Auto (Closed Loop) or Manual (Open Loop). Set Point drives the loop in Auto mode and Forced MV drives the loop power in Manual Mode. This is part of the defaults output PDO.

Actual Control Mode	0x6nn0	0x6B	0x02	Indicates the actual controlling mode Auto or Manual. If there is a sensor error the loop cannot be in the Auto mode.
Tune Occurring	0x6nn0	0x6B	0x04	Indicates if an auto-tune is in progress. Tuning is started using command 0xFB30.
Remote PV	0x3nn0	0x66	0x13	An external value may be used as the Process Variable. If the Sensor Map is set to 5. This value will be the process value and should be provided by the master in an Output PDO.

8.2 OPTICAL SENSING

RMZ4 modules (RMZ4-xx**04**-xxxx) with integrated optical sensing support these parameters. These integrated sensors are activated by setting the Sensor Bus to 4 and selecting instance 1, 2, 3, or 4. These parameters are also available from RMF modules connected and mapped as a normal RM module input in that case.

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Optical Sensor Type	0x4nn1	0x68	0x14	Sets a sensor curve to match the connected probe type. The device supports 3 probe curves. **After changing the curve type, send a SaveNonVolatileParameters command and cycle power to the unit. The probe curve is only loaded on power-up.** 0 = Type 0 is the Watlow standard probe 1 = Type 1 is a legacy probe 2 = Type 2 is customizable
Optical Sensor Warning	0x4nn1	0x68	0x2E	Sets a warning point for the probe LED current. The default is 15mA. When the LED current exceeds this level the status indicator on the front on the module will flash green and red alternately. This can occur if the optical pathway is becoming opaque or the extension cable is not properly seated.
Optical Sensor Error	0x2nn0	0x65	0x02	Indicates an error with the sensor probe.
Optical Sensor LED Current	0x2nn0	0x65	0x11	Indicates the optical sensor LED current used to actuate the luminescent probe. Increasing current can indicate increasing attenuation in the extension cable.

8.3 OPEN LOOP DETECT

RMZ4 has the capability to detect if the control loop is out of control. The loop is detected as being “open” if the manipulated value of output power is not having an effect on the measure process value. Open loops can be caused by various issues. Open fuses, heaters or interlock contactors will prevent power from reaching the load. Sensors that are not in proper contact with the load will not detect changes in temperature correctly. This will cause thermal runaway. Since loads change at different rates and respond to power differently the feature is configured with an amount of change expected in a period of time. Typically the process value will not increase at all in response to 100% output power. Set the value conservatively to prevent false trips. For example, If the process would normally change 20 degrees per minute at 100% power, the feature could be set to 5 degrees in 60 seconds. This would trip if the measured process value does not change at less than ¼ its normal rate.

Configuring

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Open Loop Detect Enable	0x4nn1	0x68	0x2F	1 = Enables the Open Loop Detect Feature 0 = Disables the feature
Open Loop Detect Time	0x4nn1	0x68	0x30	Sets the amount of time given for the process value to change by at least the Deviation amount.
Open Loop Deviation	0x4nn1	0x68	0x31	Sets the amount the process value must change within the Detection Time or an open loop error will be set.

Using

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Open Loop Error Status	0x2nn0	0x65	0x04	0 = Control Loop is operating properly 1 = Control Loop is not closed, output power set to 0%.
Clear Open Loop Detect Error	0x3nn0	0x66	0x01	Clear the open loop error. The loop will function again. If the condition has not be correct the error will occur again after the power reaches 100% for the detection time.

8.4 DIGITAL HEAT CONTROL OUTPUTS

These parameters associate an RM's digital output back with the control loops in the RMZ. The RMZ4 is zone 16 so the mapping for with output will be Function=Heat, Zone=16, Instance= the RMZ4 loop number.

Mapping

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Digital Heat Bus	0x4nn0	0x67	0x15	Defines the zone that hosts the Heat Outputs. Only loops that are locally hosted can support output mapping. EZ-ZONE ST and PM, EHG SL-10 devices do not have a mechanism to map their outputs to foreign control loops. However, this will indicate where the output setup parameters like cycle time should be sent for any controller type. 0 = Unused 1 = RM 2 = Legacy ST/PM 3 = Modbus SL-10
Digital Heat Zone	0x4nn0	0x67	0x16	Defines which RM zone is providing the digital heat control output. Only loops that are locally hosted can support output mapping. EZ-ZONE ST and PM, EHG SL-10 devices do not have a mechanism to map their outputs to foreign control loops. They will use their own outputs automatically.
Digital Heat Instance	0x4nn0	0x67	0x17	Defines which digital output instance on a particular zone implement the control output.

Configuring

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Output 1 Cycle Time	0x8nn0	0x6D	0x1A	Set the cycle time for the digital heat output. The output will pulse at this rate with the duty cycle defined by the heat manipulated value (MV) power level.

Using

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Heat Manipulated Value	0x6nn0	0x6B	0x13	The heat control output value can be observed in this sub index 0.0 to 100.0%
Manipulated Value	0x6nn0	0x6B	0x12	The total control output value can be observed in this sub index whether heating or cooling -100.0 to 100.0%

8.5 Over-Temperature Limits

Over-temperature cut off is accomplished using an independent limit. The EZ-ZONE family has physically integrated yet independent limit circuits to provide thermal protection. Systems can be protected from thermal runaway by interlocking through the relay output of the limit circuit. The limit has its own input sensor to configure as well as trip points to configure. The limit relay will open if a limit condition occurs. The limit must be cleared by the system master after the limit condition has cleared, it will not self clear.

Mapping

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Limit Bus	0x4nn0	0x67	0x1B	Sets the bus where the over-temp sensing function is located. Over-temp control has dedicated trip circuitry. This extra sensor is read at 0:2000:14 for verification. The limit is parameterized in the RMZ4 with trip points that are routed to the appropriate RML, RMC, ST or PM module. The limit function and output are independently controlled by the limit module but parameterized through the RMZ. 0: Unused 1 = RM 2 = Legacy ST/PM 3 = Modbus SL-10
Limit Zone	0x4nn0	0x67	0x1C	Defines which zone is hosting the limit sub module.
Limit Instance	0x4nn0	0x67	0x1D	Defines which limit sub-module corresponds to this control loop.

Configuring

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Limit Sensor Type	0x4nn1	0x68	0x1E	Sets the limit input type to 0 = TC 1 = RTD100 2 = RTD1000 3 = 4-20mA 4 = 0-20mA 5 = 0-10V
Limit Thermocouple Type	0x4nn1	0x68	0x1F	Set the limit thermocouple type to 0: K 1: J 2: T 3: E 4: N 5: R 6: S 7: B 8: C 9: D 10: F
Limit Function	0x4nn1	0x68	0x15	Set the limit type to 0 = Disabled

				1 = High Only 2 = Low Only 3 = Both High and Low Trip Enabled
Limit Hysteresis	0x4nn1	0x68	0x16	Set the hysteresis for the limit, which is how far back into the safe band the temperature must return before the limit can be cleared.
Limit Over-Temp Trip Point	0x8nn0	0x6D	0x34	Sets the high trip point where the over temperature relay will open.
Limit Under-Temp Trip Point	0x8nn0	0x6D	0x35	Sets the low trip point where the under temperature relay will open.
Limit Set Point Upper Bound	0x4nn1	0x68	0x17	Define the maximum settable trip point value.
Limit Set Point Lower Bound	0x4nn1	0x68	0x18	Define the minimum settable trip point value.

Using

Parameter	**ECAT Index**	**DNET Class**	**Sub /Attr**	**Description**
Limit Temperature Reading	0x2nn0	0x65	0x14	Indicates the current temperature of the limit sensor.
Limit Sensor Error	0x2nn0	0x65	0x01	Indicates if the limit sensor is valid or in error. If the sensor is in error, the temperature reading will return 9999.9C and be invalid. The limit circuit will also open the relay on any sensor error.
Limit Condition	0x6nn0	0x68	0x18	Indicates if a limit condition is occurring.
Limit Clear	0x3nn0	0x66	0x11	Write a 1 to this index to clear a tripped limit. The limit can be cleared if: 1. The sensor reading is valid. 2. The temperature is within the trip points.

8.6 CURRENT SENSING

Heat outputs may be associated with a current sensor. The RM uses current transformers and the ST uses a built in current sensor. This will report the RMS current flowing through the heater. High and low trip points may be configured.

Mapping

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Current Sense Bus	0x4nn0	0x67	0x1E	Defines the bus connected to the current sensing module. This is typically an RME, RMC, or ST. The current sensing circuit needs to be associated with output controlling the heater to compare measured output against the desired output to generate errors when the current is not in alignment with the output signal. 0 = Unused 1 = RM 2 = Legacy ST/PM 3 = Modbus SL-10
Current Sense Zone	0x4nn0	0x67	0x1F	Defines which zone is hosting the current sense functionality.
Current Sense Instance	0x4nn0	0x67	0x20	Defines which current sense instance belongs to this loop in a module that hosts multiple current sensors.

Configuring

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Heater Failure Function	0x4nn1	0x68	0x19	
Current Trip Level High	0x4nn1	0x68	0x1A	A heater fault is generated if the RMS current exceeds this point.
Current Trip Level Low	0x4nn1	0x68	0x1B	A heater fault is generated if the RMS current falls below this point. This is used to detect the loss of a heater or fuse.
Current Transformer Scaling High	0x4nn1	0x68	0x1C	Matches the current reading to the Current Transformer (CT) used and the number of wire windings.
Current Transformer Offset	0x4nn1	0x68	0x1D	Allows user calibration of the current reading.

Using

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
RMS Current Value	0x6nn0	0x6B	0x15	Provides a reading of the heater current.
Heater Fault	0x2nn0	0x65	0x12	Indicates the trip points have been exceeded.

8.7 COOLING DIGITAL OUTPUTS

Cool outputs are driven off the same control loop as the heat output and map negative power to this cool outputs when it is mapped. These are slow switching PWM for PID or simple ON/OFF.

Mapping

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Digital Cooling Bus	0x4nn0	0x67	0x28	Specifies the bus connected to the device hosting the digital cool output. Only loops that are locally hosted can support output mapping. EZ-ZONE ST and PM, EHG SL-10 devices do not have a mechanism to map their outputs to foreign control loops. Cool outputs parameters like cycle time need this location even if they are hosted remotely. 0 = Unused 1 = RM 2 = Legacy ST/PM 3 = Modbus SL-10
Digital Cooling Zone	0x4nn0	0x67	0x29	Defines which RM zone is providing the digital cool control output. Only loops that are locally hosted can support output mapping. EZ-ZONE ST and PM, EHG SL-10 devices do not have a mechanism to map their outputs to foreign control loops. They will use their own outputs automatically. Still associate this with ST and PM devices to ensure proper parameter routing.
Digital Cooling Instance	0x4nn0	0x67	0x2A	Defines which digital output instance on a particular zone implement the cool control output. The cooling algorithm may be set to PID or ON/OFF with hysteresis.

Configuring

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Output 2 Cycle Time	0x8nn0	0x6D	0x1B	Set the cycle time for the digital cool output. The output will pulse at this rate with the duty cycle

				defined by the cool manipulated value (MV) power level.

Using

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Cool Manipulated Value	0x6nn0	0x6B	0x14	The cool control output value can be observed in this sub index 0.0 to 100.0%
Manipulated Value	0x6nn0	0x6B	0x12	The total control output value can be observed in this sub index whether heating or cooling -100.0 to 100.0%

8.8 Analog Heat Outputs

Analog outputs can drive analog actuator like valves, power controller or phase angle SSR. The heat output level is determined by the control loop and PID. This configuration routes the power to an analog output and allows appropriate scaling.

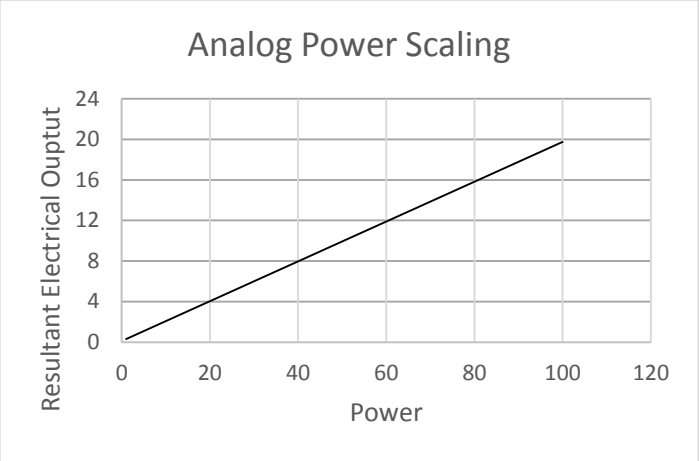
Mapping

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Analog Heat Bus	0x4nn0	0x67	0x18	Specifies the bus connected to the device hosting the analog heat output. This is only applicable to EZ-ZONE RM device. 0 = Unused 1 = RM back plane.
Analog Heat Zone	0x4nn0	0x67	0x19	Defines which RM zone is providing the analog heat output.
Analog Heat Instance	0x4nn0	0x67	0x1A	Defines which analog output in the mapped module provides the heat output.

Configuring

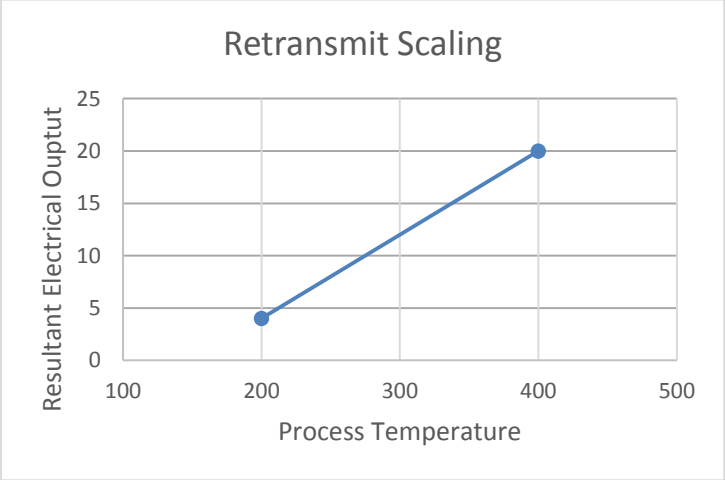
Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Analog Heat Output Type	0x4nn1	0x68	0x21	0 = Milliamps 1 = Volts
Analog Heat Output Electrical High	0x4nn1	0x68	0x23	This is the analog output value associated with 100% heat power such as 10V or 20mA
Analog Heat Output Electrical Low	0x4nn1	0x68	0x24	This is the analog output value associated with 0% heat power such as 0V or 4mA.

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Heat Manipulated Value	0x6nn0	0x6B	0x13	The heat control output value can be observed in this sub index 0.0 to 100.0%
Manipulated Value	0x6nn0	0x6B	0x12	The total control output value can be observed in this sub index whether heating or cooling -100.0 to 100.0%



8.9 Analog Retransmit Outputs

Analog outputs can retransmit the loop's process value for use by external devices. The analog output is scaled from the temperature reading using a transfer function defined using 4 parameters, 2 process values and the matching 2 electrical values. This defines a line that maps any temperature to an appropriate analog value.



Mapping

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Analog Heat Retransmit Bus	0x4nn0	0x67	0x18	Specifies the communication bus connects to the output module for the analog retransmit output. This is only applicable to EZ-ZONE RM device. 0 = Unused 1 = RM back plane.
Analog Heat Retransmit Zone	0x4nn0	0x67	0x19	Defines which device zone/address on the bus is providing the analog retransmit output.
Analog Heat Retransmit Instance	0x4nn0	0x67	0x1A	Defines which output in this device provides the analog retransmit output.

Configuring

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Analog Retransmit Output Type	0x4nn1	0x68	0x28	0=Milliamps 1=Volts
Analog Retransmit Output Scale High	0x4nn1	0x68	0x29	This is the process value that maps to the high electrical retransmit output. (0x4nn1:28) such as 500 Degrees C.
Analog Retransmit Output Scale Low	0x4nn1	0x68	0x2A	This is the process value that maps to the high electrical retransmit output. (0x4nn1:29) such as 100 Degrees C.

Analog Retransmit Output Electrical High	0x4nn1	0x68	0x2B	This is the electrical analog output value associated with the Scale High value (0x4nn1:26) such as 10V or 20mA.
Analog Retransmit Output Electrical Low	0x4nn1	0x68	0x2C	This is the electrical analog output value associated with the Scale High value (0x4nn1:27) such as 0V or 4mA.

8.10 ALARM OUTPUTS

Mapping Process Alarm 1

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Process Alarm 1 Bus	0x4nn0	0x67	0x2B	Specifies the communication bus connects to the outputs for the process alarm 1. 0 = Unused 1 = RM 2 = Legacy ST/PM 3 = Modbus SL-10
Process Alarm 1 Zone	0x4nn0	0x67	0x2C	Defines which device zone/address on the bus provides the process alarm 1.
Process Alarm 1 Instance	0x4nn0	0x67	0x2D	Defines which output in this device provides the process alarm 1 output.

Mapping Deviation Alarm 2

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Deviation Alarm 2 Bus	0x4nn0	0x67	0x2E	Specifies the communication bus connects to the outputs for the deviation alarm 2 0 = Unused 1 = RM 2 = Legacy ST/PM
Deviation Alarm 2 Zone	0x4nn0	0x67	0x2F	Defines which device zone/address on the bus provides the output for deviation alarm 2.
Deviation Alarm 2 Instance	0x4nn0	0x67	0x30	Defines which output in this device provides the output for deviation alarm 2.

Configuring

Parameter	ECAT Index	DNET Class	Sub /Attr	Description

Alarm 1 Enable	0x8nn0	0x6D	0x14	0 = Disable the process alarm 1 = Enabled the process alarm
Alarm 1 High Set Point	0x8nn0	0x6D	0x2C	The point where a high alarm 1 becomes active. This is an absolute temperature.
Alarm 1 Low Set Point	0x8nn0	0x6D	0x2D	The point where a low alarm 1 becomes active. This is an absolute temperature.
Alarm 1 Set Point Upper Bound	0x8nn0	0x6D	0x2E	Alarm 1 High Set Point cannot be set above this value. This is typically set as the maximum allowable for the tool.
Alarm 1 Set Point Lower Bound	0x8nn0	0x6D	0x2F	Alarm 1 Low Set Point cannot be set below this value. This is typically set as the minimum allowable for the tool.

Parameter	**ECAT Index**	**DNET Class**	**Sub /Attr**	**Description**
Alarm 2 Enable	0x8nn0	0x6D	0x15	0 = Disable the deviation alarm 1 = Enabled the deviation alarm
Alarm 2 High Set Point	0x8nn0	0x6D	0x30	The point where a high alarm 2 becomes active. This is a temperature relative to this loops set point, typically a positive number like 20C.
Alarm 2 Low Set Point	0x8nn0	0x6D	0x31	The point where a low alarm 2 becomes active. This is a temperature relative to this loops set point, typically a negative number like -20C.
Alarm 2 Set Point Upper Bound	0x8nn0	0x6D	0x32	Alarm 2 High Set Point cannot be set above this value. This is typically set as the maximum allowable for the tool.
Alarm 2 Set Point Lower Bound	0x8nn0	0x6D	0x33	Alarm 2 Low Set Point cannot be set below this value. This is typically set as the minimum allowable for the tool.

Using

Parameter	**ECAT Index**	**DNET Class**	**Sub /Attr**	**Description**
Alarm Condition	0x6nn0	0x6B	0x17	For each loop with will indicate if either of the 2 alarms is active. 0x0001 = Process alarm condition present 0x0002 = Deviation alarm condition present 0x0003 = Both alarm conditions present

8.11 Analog Cooling Outputs

Cool outputs can drive analog actuator like valves, chillers or variable speed fans. The cool output level is determined by the control loop and PID. This configuration routes the cool power to an analog output and allows appropriate scaling.

Mapping

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Analog Cool Output Bus	0x4nn0	0x67	0x32	Specifies the communication bus connects to the analog outputs for the cooling action. This is only applicable to EZ-ZONE RM device. 0 = Unused 1 = RM back plane.
Analog Cool Output Zone	0x4nn0	0x67	0x33	Defines which device zone/address on the bus provides the analog cooling output.
Analog Cool Output Instance	0x4nn0	0x67	0x34	Defines which output in this device provides the analog cooling output.

Configuring

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Analog Cool Output Type	0x4nn1	0x68	0x25	0 = Milliamps 1 = Volts
Analog Cool Output Electrical High	0x4nn1	0x68	0x26	This is the analog output value associated with 100% cool power such as 10V or 20mA
Analog Cool Output Electrical Low	0x4nn1	0x68	0x27	This is the analog output value associated with 0% cool power such as 0V or 4mA.

Using

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Cool Manipulated Value	0x6nn0	0x6B	0x14	The cool control output value can be observed in this sub index 0.0 to 100.0%
Manipulated Value	0x6nn0	0x6B	0x12	The total control output value can be observed in this sub index whether heating or cooling -100.0 to 100.0%

8.12 DIRECT DIGITAL INPUT

Direct digital inputs are made available for reading from the EtherCAT network. Map this point to the appropriate Digital input. The value is may be mapped to a User PDO.

Mapping

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Direct Digital Input Bus	0x4nn0	0x67	0x35	Specifies the communication bus that connects to the module containing direct digital input. This is only applicable to EZ-ZONE RM device. 0 = Unused 1 = RM back plane.
Direct Digital Input Zone	0x4nn0	0x67	0x36	Defines which device zone/address on the bus provides the direct digital input.
Direct Digital Input Instance	0x4nn0	0x67	0x37	Defines which output in this device provides the direct digital input.

Using

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Direct Digital Input Value	0x6nn0	0x6B	0x19	The digital input is available in this Sub-Index as 0 or 1. This value is can be mapped to the User PDO.

8.13 DIRECT DIGITAL OUTPUT

Direct digital outputs are controlled directly from the EtherCAT network. They are not controlled by algorithms in the RM system. This allows any digital output point in the RM system to be controlled remotely. The value can be mapped to User PDO.

Mapping

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Direct Digital Output Bus	0x4nn0	0x67	0x38	Specifies the communication bus that connects to module containing the direct digital output. This is only applicable to EZ-ZONE RM device. 0 = Unused 1 = RM back plane.
Direct Digital Output Zone	0x4nn0	0x67	0x39	Defines which device zone/address on the bus provides the direct digital output.
Direct Digital Output Instance	0x4nn0	0x67	0x3A	Defines which output in this device provides the direct digital output.

Using

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Direct Digital Output Value	0x7nn0	0x6C	0x14	The directly mapped Digital output is set via this Sub-Index as 0 or 1. This value is can be mapped to the User PDO.

8.14 DIRECT ANALOG INPUT

Direct analog inputs are any sensor or process input in the RM system. These can be monitored directly from the EtherCAT network. The point may be mapped to User PDO. Make sure this input is not used by a control loop or limit. The configurations would interfere with each other.

Mapping

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Direct Analog Input Bus	0x4nn0	0x67	0x3B	Specifies the communication bus that connects to the analog input module. This is only applicable to EZ-ZONE RM device. 0 = Unused 1 = RM back plane.
Direct Analog Input Zone	0x4nn0	0x67	0x3C	Defines which device zone/address on the bus provides the analog input.
Direct Analog Input Instance	0x4nn0	0x67	0x3D	Defines which input in this device provides the analog input.

Configuring

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Direct Analog Input Sensor Type	0x4nn1	0x68	0x32	This is the sensor type for the direct digital input. 0 = TC 1 = RTD100 2 = RTD1000 3 = 4-20mA 4 = 0-20mA 5 = 0-10V
Direct Analog Input TC Type	0x4nn1	0x68	0x33	This is the sensor type for the direct digital input. 0: K 1: J 2: T 3: E 4: N 5: R 6: S 7: B 8: C 9: D 10: F
Process Scale High for Direct Analog Input	0x4nn1	0x68	0x34	This is the input value associated with the high electrical signal such as 0V or 4mA.
Process Scale Low for Direct Analog Input	0x4nn1	0x68	0x35	This is the input value associated with the low electrical signal such as 0V or 4mA.

Using

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Direct Analog Input Value	0x2nn0	0x65	0x16	This is the most recent, live value of this input. This value can be mapped to the User PDO.

8.15 DIRECT ANALOG OUTPUT

Direct digital outputs are controlled directly from the EtherCAT network. They are not controlled by algorithms in the RM system. This allows any analog output in the RM system to be controlled remotely. The value can be mapped to User PDO. This output share scaling with the cool analog output.

Mapping

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Direct Analog Output Bus	0x4nn0	0x67	0x3E	Specifies the communication bus connects to the analog outputs for the cooling action. This is only applicable to EZ-ZONE RM device. 0 = Unused 1 = RM back plane.
Direct Analog Output Zone	0x4nn0	0x67	0x3F	Defines which device zone/address on the bus provides the analog cooling output.
Direct Analog Output Instance	0x4nn0	0x67	0x40	Defines which output in this device provides the analog cooling output.

Configuring

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Analog Cool Output Electrical High	0x4nn1	0x68	0x26	This is the analog output value associated with 100% cool power such as 10V or 20mA
Analog Cool Output Electrical Low	0x4nn1	0x68	0x27	This is the analog output value associated with 0% cool power such as 0V or 4mA.

Using

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Direct Analog Output Value	0x3nn0	0x66	0x14	The output can be set here via SDO. This value can be mapped to the User PDO.

8.16 ALARM GROUPS

Each loop has a process and deviation alarm. These can be individually mapped to output. However many application want to trigger an output is *any* of a group of alarms is active. The RMZ4 provides 8 alarm groups to facilitate alarm aggregation. Each group may be mapped to a digital output. The group provides a means to pick which active alarms are part of the group from any control loop. The groups are configured in the 0x5F00 object. The control loops are assigned a group in the 8 Pick Lists 0x5F01 to 0x5F08. The groups are not slot/module based since they are not associated one to one with the control loops. Groups can be used to energize a contactor when all control loops associated with that power distribution bus are operating properly.

Mapping and Configuration

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Alarm Group 1 Logic	0x5F00	0x69	0x11	Specifies the logic state taken when any of the picked alarms is active. 0 = If any alarm is condition matches the pick for the group, the group will be FALSE. 1 = If any alarm is condition matches the pick for the group, the group will be TRUE.
Alarm Group 1 Output Bus	0x5F00	0x69	0x12	Defines which bus hosts the digital alarm group 1 output. This is only applicable to EZ-ZONE RM device. 0 = Unused 1 = RM back plane.
Alarm Group 1 Output Zone	0x5F00	0x69	0x13	Defines which zone on the bus hosts the digital alarm group 1 output
Alarm Group 1 Output Instance	0x5F00	0x69	0x14	Defines which output in the zone implements the digital alarm group 1 output.
Alarm Group 2 Logic	0x5F00	0x69	0x15	Specifies the logic setting for alarm group 2.
Alarm Group 2 Output Bus	0x5F00	0x69	0x16	Defines which bus hosts the alarm group 2 output. This is only applicable to EZ-ZONE RM device. 0 = Unused 1 = RM back plane
Alarm Group 2 Output Zone	0x5F00	0x69	0x17	Defines which zone on the bus hosts the alarm group 2 output
Alarm Group 2 Output Instance	0x5F00	0x69	0x18	Defines which output in the zone implements the digital alarm group 2 output.
Alarm Group 3 Logic	0x5F00	0x69	0x19	Specifies the logic setting for alarm group 3.
Alarm Group 3 Output Bus	0x5F00	0x69	0x1A	Defines which bus hosts the alarm group 3 output. This is only applicable to EZ-ZONE RM device. 0 = Unused 1 = RM back plane

Alarm Group 3 Output Zone	0x5F00	0x69	0x1B	Defines which zone on the bus hosts the alarm group 3 output
Alarm Group 3 Output Instance	0x5F00	0x69	0x1C	Defines which output in the zone implements the digital alarm group 2 output.
Alarm Group 4 Logic	0x5F00	0x69	0x1D	Specifies the logic setting for alarm group 4. This is only applicable to EZ-ZONE RM device. 0 = Unused 1 = RM back plane
Alarm Group 4 Output Bus	0x5F00	0x69	0x1E	Defines which bus hosts the alarm group 4 output.
Alarm Group 4 Output Zone	0x5F00	0x69	0x1F	Defines which zone on the bus hosts the alarm group 4 output
Alarm Group 4 Output Instance	0x5F00	0x69	0x20	Defines which output in the zone implements the digital alarm group 4 output.
Alarm Group 5 Logic	0x5F00	0x69	0x21	Specifies the logic setting for alarm group 5.
Alarm Group 5 Output Bus	0x5F00	0x69	0x22	Defines which bus hosts the alarm group 5 output. This is only applicable to EZ-ZONE RM device. 0 = Unused 1 = RM back plane
Alarm Group 5 Output Zone	0x5F00	0x69	0x23	Defines which zone on the bus hosts the alarm group 5 output
Alarm Group 5 Output Instance	0x5F00	0x69	0x24	Defines which output in the zone implements the digital alarm group 5 output.
Alarm Group 6 Logic	0x5F00	0x25	0x25	Specifies the logic setting for alarm group 6.
Alarm Group 6 Output Bus	0x5F00	0x26	0x26	Defines which bus hosts the alarm group 6 output. This is only applicable to EZ-ZONE RM device. 0 = Unused 1 = RM back plane
Alarm Group 6 Output Zone	0x5F00	0x69	0x27	Defines which zone on the bus hosts the alarm group 6 output
Alarm Group 6 Output Instance	0x5F00	0x69	0x28	Defines which output in the zone implements the digital alarm group 6 output.
Alarm Group 7 Logic	0x5F00	0x69	0x29	Specifies the logic setting for alarm group 7.
Alarm Group 7 Output Bus	0x5F00	0x69	0x2A	Defines which bus hosts the alarm group 7 output.
Alarm Group 7 Output Zone	0x5F00	0x69	0x2B	Defines which zone on the bus hosts the alarm group 7 output
Alarm Group 7 Output Instance	0x5F00	0x69	0x2C	Defines which output in the zone implements the digital alarm group 7 output.
Alarm Group 8 Logic	0x5F00	0x69	0x2D	Specifies the logic setting for alarm group 8.
Alarm Group 8 Output Bus	0x5F00	0x69	0x2E	Defines which bus hosts the alarm group 8 output.

Alarm Group 8 Output Zone	0x5F00	0x69	0x2F	Defines which zone on the bus hosts the alarm group 8 output.
Alarm Group 8 Output Instance	0x5F00	0x69	0x30	Defines which output in the zone implements the digital alarm group 8 output.

Alarm Picking

Each sub index corresponds to a control loop module's involvement. For each group select with alarm actions of a loop get incorporated in that alarm group.

Parameter	**ECAT Index**	**DNET Class**	**Sub /Attr**	**Description**
Alarm Group 1 Pick List	0x5F01	0x6A	0x01	Determines how alarms from loop 1 map into the group. 0 = Not part of the group 1 = Process alarms activate the group 2 = Non occurring process alarms activate the group 3 = Deviation alarms activate the group 4 = Non occurring deviation alarms activate the group 5 = A process AND a deviation alarm with activate the group 6 = A process OR a deviation alarm will activate the group.
	0x5F01	0x6A	0x02	Determines how alarms from loop 2 map into group 1.
		….	….	For each loop…
	0x5F01	0x6A	0x30	Determines how alarms from loop 48 map into group 1.
Alarm Group 2 Pick List	0x5F02	0x6A	0x01 … 0x30	Determines how alarms from loop nn map into group 2.
Alarm Group 3 Pick List	0x5F03	0x6A	0x01 … 0x30	Determines how alarms from loop nn map into group 3.
Alarm Group 4 Pick List	0x5F04	0x6A	0x01 … 0x30	Determines how alarms from loop nn map into group 4.
Alarm Group 5 Pick List	0x5F05	0x6A	0x01 … 0x30	Determines how alarms from loop nn map into group 5.
Alarm Group 6 Pick List	0x5F06	0x6A	0x01 … 0x30	Determines how alarms from loop nn map into group 6.
Alarm Group 7 Pick List	0x5F07	0x6A	0x01 … 0x30	Determines how alarms from loop nn map into group 7.
Alarm Group 8 Pick List	0x5F08	0x6A	0x01 … 0x30	Determines how alarms from loop nn map into group 8.

Using

These are the output values form each group. This value maps to the digital output. The logic setting in the group will invert this value.

Parameter	ECAT Index	DNET Class	Sub /Attr	Description
Alarm Group 1 Value	0x5F00	0x69	0x01	The output value for alarm group 1, True or False.
Alarm Group 2 Value	0x5F00	0x69	0x02	The output value for alarm group 2, True or False.
Alarm Group 3 Value	0x5F00	0x69	0x02	The output value for alarm group 3, True or False.
Alarm Group 4 Value	0x5F00	0x69	0x02	The output value for alarm group 4, True or False.
Alarm Group 5 Value	0x5F00	0x69	0x02	The output value for alarm group 5, True or False.
Alarm Group 6 Value	0x5F00	0x69	0x02	The output value for alarm group 6, True or False.
Alarm Group 7 Value	0x5F00	0x69	0x02	The output value for alarm group 7, True or False.
Alarm Group 8 Value	0x5F00	0x69	0x02	The output value for alarm group 8, True or False.

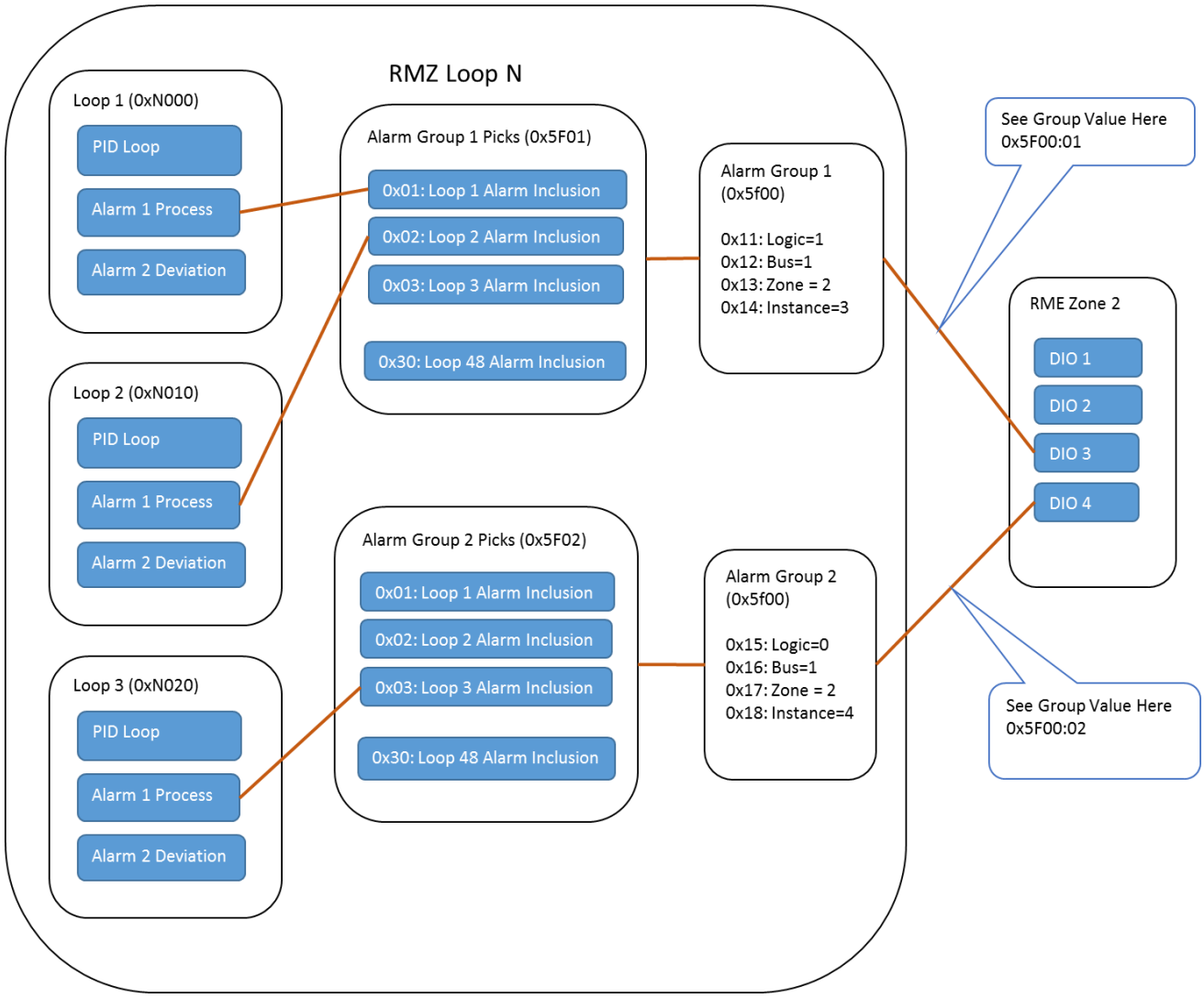


FIGURE 12 - ALARM GROUP EXAMPLE

9 SETTING PARAMETERS AND RUNNING

With the I/O mapped to the correct RM or ST the system is ready to be setup and run. Consider if it makes sense to execute a SaveNonVolatile command to store all the I/O mapping for immediate recall on power-up. While a typical EtherCAT® system will write all required parameter to the RMZ4 while before the operational mode is started, there is advantage to store the most desired configuration then ensure it is correct by checking or simply writing again. This eliminates configuration latency on power up.

9.1 USING PDOS

Each loop has a default set of PDO input and outputs for normal sensor monitoring and set point and mode delivery. Each loop also has a set of user definable PDOs. The user can load these with parameters of interest on a loop by loop basis. The only limitation is that the items loaded into each loop must be parameters belonging to that loop.

9.2 RUNNING

To operate the control loops, the loop must have the Control State set to On. The Safe Mode defines if the control loops can continue to operate if the EtherCAT® state transitions to the Safe State to prevent undesired cool-downs if desired. The Target Set Point, Control Mode, and Control State are by default provided by the Output PDOs once the system entered the operational mode. The must be set using the PDOs then the device is in operational mode.

9.3 TUNING

Tuning is a process that sets the PID values for a control loop automatically using a standard Zielger-Nichols algorithm. The system is put into oscillation below the Set point. The controller observes the responses to determine the systems gain and time constant. From that information appropriate PID values are calculate and put into effect. The process will return the controller to normal closed loop mode once the tune in complete.

The control loops may be tuned individually, in groups, or all at the same time via the InitiateTune command. The PID value can be set directly as well. The tune command takes a list of loops to tune. This is a string of bytes. This list of byte 0102030A10 will initiate a tune of loops 1, 2, 3, 10, and 16. To see if a loop is tuning, look at the TuneActive bit in the 0x6nn0:04. Sending 0 as the list will initiate a tune on all configured loops.

Tuning can be cancel on any loop using the CancelTune command. This uses the same command strings as the InitiateTune command, individual loops with a list or all with 0.

10 EtherCAT® Protocol

The EtherCAT® implementation supports CoE (CANOpen over EtherCAT®) and FoE (File over EtherCAT®). CoE defines the mapping of device parameters to Indexes and Sub Indexes. FoE is used to write new application code into the product for revision upgrades.

10.1 Device Objects

Each system object type is mapped to an Index. In the Watlow EtherCAT® Adapter, objects are structured as arrays of objects representing each control loop separated by 0x10. The Sub Indexes within each index are the individual parameters that comprise the objects. EtherCAT® indexes are mapped to class instances using the Modular Device topology. Input data for loop 1 is located at index 0x6000. Input data for loop 2 in located at index 0x6010, etc. Items in the 0x200, 0x3000, 0x6000 and 0x7000 parameters can be mapped to the PDO sets.

Index	Description	Details	Modular
0x1000	Identity Object	Device Name, Vendor ID, serial number…	No
0x2000	Watlow Specific Input Data	Limit sensor	Yes
0x3000	Watlow Specific Output Data	SP, Desired States…	Yes
0x4000	Watlow Specific I/O Mapping	TC Types, Ranges, Alarm Points…	Yes
0x4001	Watlow Specific Configuration	Cooling, Limits and CT parameters	Yes
0x5F00	Alarm Grouping	Aggregates Alarms	No
0x6000	Input Data	PV, Errors, Actual States, Current…	Yes
0x7000	Output Data	SP, Desired States…	Yes
0x8000	Configuration Parameters	TC Types, Ranges, Alarm Points…	Yes
0xF000	Device Specifics	Number of Modules, Module Index Offset…	No
0xF300	Exceptions	Exceptions and fault indication	No
0xF500	Watlow Attached Devices	RM and ST details	No
0xF600	Input Status	Status of PDO updates	No
0xF900	Information	Which features are present, generation of specs	No
0xFA00	Diagnostic Messages	Event log and EtherCAT® issue log	No
0xFB00	Commands	Start Autotune, Store parameters, Reset device	No

Loops are mapped to repeating indexes with an offset of 0x0010 between Modular Object indexes.

A standard listing of objects is available in the Semi SDP ETG.5003.2060 from the EtherCAT website.

http://www.ethercat.org

The complete list of SDP and Watlow Specific objects is available from the Watlow website as an Excel spreadsheet.

http://www.watlow.com

Search “Watlow EtherCAT SDP”

10.2 COMMANDS

These are on-demand actions initiated from the master.

0xFB30 Start auto tuning a loop

The command is a list of loops as string.
Example: “1,3,8” will start tuning loops 1, 3, and 8

Zero will tune all zones
Example: “0” will start tuning on all loops

Additional method for version 2.0 or later:

The command is an array of bytes for the loops to tune.
Example: 0x010308 will start tuning loops 1, 3, and 8

Zero will tune all zones
Example: 0x00 will start tuning on all loops

0xFB31 Cancel a tune

The command is a list of loops as string.
Example: “2,5,10” will stop tuning loops 2,5, and 10

Zero will stop tune on all zones
Example: “0” will stop tuning on all loops

Additional method for version 2.0 or later:

The command is an array of bytes for the loops to stop.
Example: 0x02050A will stop tuning loops 2, 5, and 10

Zero will stop tune on all zones
Example: 0x00 will stop tuning on all loops

0xFBF0 Reset Device - both device restart and restore factory configuration

The command is a text string.
“teser” will reboot the device.
“teserf” will reset the device to factory parameters.

0xFBF1 Reset Exceptions

The command is a byte. Writing 0x01 will cause any expectations to be cleared.

0xFBF2 Store parameters to Non-volatile memory

The command is a code to cause the configuration parameters to get stored to NV memory. Otherwise the parameters will be lost on power cycle.

0x65766173 causes the parameters to be stored
A status of 0 means no action.
A status of 100 means in-progress.
A status of 200 means complete.

0xFBF3 Calculate Parameter Checksum(s)

The command is a byte. Writing 0x01 will cause the checksum recalculation of all 0x4000 and 0x8000 parameters.
A status of 0 means no action.
A status of 100 means in-progress.
A status of 200 means complete.

10.3 DEFAULT RXPDO

This is the data received by the controller every scan cycle (usually 1-10ms as controlled by the master). It is configured at index 0x1600 predefined standard data points and 0x1601 for user defined data points for loop1, 0x1602/0x1603 for loop2, etc. The parameters in the user defined (odd numbered) PDO can be changed by changing the Entry Index and Entry Sub Index contained in the PDO sub index but this is global, not on a per-module basis. The even PDOs are a standard set defined by the Standard Device Profile (SDP) and are fixed.

PDO Sub Index	Name	PDO Entry Index	PDO Entry Sub Index	PDO Entry Name
0x01	Sub Index 001	0x7nn0	0x11	Target Set Point Loop nn
0x02	Sub Index 002	0x7nn0	0x13	Clear Alarms Loop nn
0x03	Sub Index 003	0x7nn0	0x12	Forced MV Loop nn
0x04	Sub Index 004	0x7nn0	0x02	Control Mode Loop nn
0x05	Sub Index 005	0x7nn0	0x01	Control State Loop nn

10.4 DEFAULT TXPDO

This is the data received by the controller every scan cycle (usually 1-10ms as controlled by the master). Is it configured at index 0x1A00 for loop1, 0x1A02 for loop2, etc.

PDO Sub Index	Name	PDO Entry Index	PDO Entry Sub Index	PDO Entry Name
0x01	Sub Index 001	0x6nn0	0x11	Process Value Loop nn
0x02	Sub Index 002	0x6nn0	0x17	Alarm Condition Loop nn
0x03	Sub Index 003	0x6nn0	0x12	Manipulated Value (Control Output) Loop nn
0x04	Sub Index 004	0x6nn0	0x16	Controlling Set Point Loop nn
0x05	Sub Index 005	0x6nn0	0x01	Actual Control State Loop nn
0x06	Sub Index 006	0x6nn0	0x03	Sensor Error Loop nn
0x07	Sub Index 007	0x6nn0	0x02	Actual Control Loop Mode Loop nn

10.5 USER RXPDO

Users can define their own PDO data in the 0x1601, 0x1603, 0x1605… Any RX map-able PDO can be placed in this area. Each module/slot can have its own User RxPDO set. The only constraint is that the parameters must be part of this Loop/Module.

10.6 USER TXPDO

Users can define their own PDO data in the 0x1A01, 0x1A03, 0x1A05… Any TX map-able PDO can be placed in this area. Each module/slot can have its own User TxPDO set. The only constraint is that the parameters must be part of this Loop/Module.

11 CONTROL OPERATION

11.1 NETWORK STATE AND CONTROL STATES

EtherCAT® networks have a defined state Boot, Init, Pre-OP, Safe-Op and Operational. The control loops will function as defined by the Safe State Parameter 0x8nnn SI 0x16 at startup until the network state changes to Operational. At that point the Control State will change from OFF to RUN (if the Desired Control State is set to RUN).

If the control loops running in the EtherCAT® module lose connection with the RMS module, the loop will enter a fault state and the control mode for that loop will go to the Safe Mode configured in parameter 0x8nnn SI 0x16.

If the outputs in the RME modules lose connection with the control loop in the EtherCAT® adapter module, the modules will turn off until the link is re-established.

The exception reporting will indicate the loss of communication with modules in the system.

11.2 DATA RETENTION

EtherCAT® master applications typically configure the application on power-up to ensure correct settings before the system is made operational. Configuration will not be stored to non-volatile memory automatically. The master must issue an explicit store of parameters to non-volatile memory command. It does not occur implicitly behind the scenes.

To cause the configuration parameters to be stored to non-volatile memory, the master needs to write to Command 0xFBF2 with 0x65766173 to cause the parameters to be stored. The advantage of storing in non-volatile is the system I/O will be configured properly at power-up before the master ensures it is correct.

11.3 CONTROL LOOPS

The EtherCAT® adapter supports up to 48 control loops that execute in the adapter itself. The process variable for each loop is consumed from the RMS, RMH, or RMC modules. The outputs generated by the control loops are published and the RME, RMC modules are configured to consume these as their power level. The control loops will function as soon as the Control State is set to RUN. Once the system is operational, you can use the Autotune command to determine PID values that are optimal for the system.

11.4 ALARMS

The EtherCAT® adapter module has two alarms per control loop. Alarm1 is a process alarm and Alarm2 is a deviation alarm. The PV source for each loop is mapped to the PV and SP for the associated alarms. The user may enable or disable each alarm but the alarm type and sources cannot be changed. The alarm status is available in the 0x6000 objects and in the exception object 0xF381.

12 ADDITIONAL CONNECTIVITY

12.1 BLUETOOTH®

The EtherCAT® adapter can host an optional Bluetooth® module that contains the antenna, radio and firmware. This interface can assist with monitoring you system during development and test. This port streams XML containing readings and parameters. Android applications will be forthcoming.

The Bluetooth® module can be powered down from the processor for secure environments ensuring it will not pair.

The EtherCAT® devices will be identified on the Bluetooth® network as "EtherCATXXXXXXXX" where XXXXXXXX is the devices serial number. The device will appear in Windows® as a COM port.

This device complies with Part 18 of the FCC Rules (Section 18.212) and contains a Transmitter Module.

FCC ID: X3ZBTMOD5 IC: 8828A-MOD4 Bluetooth SIG Qualified Design, QD ID: B019224

12.2 MODBUS® SLAVE

The 2000, 3000, 4001, 6000, 7000, 8000 indexes map into the 6000 and 7000 banks of Modbus® registers with each control loop instance having an offset of 50. The primary purpose is to support HMI user interfaces that are Modbus masters.

12.3 MODBUS® MASTER

Not implemented in release 1. This will collect data from modus slave devices and present it in the EtherCAT® data model, allowing control of legacy Modbus controllers.

13 FLASH LOADING

13.1 OVER ETHERCAT®

The device firmware may be updated over EtherCAT using the FoE (File over EtherCAT) service. This is the process:

1. The master placed the RMZ4 in BOOT mode to accept the file.
2. The master download the file (*.bin) via FOE
3. The master changes the mode to INIT.
4. The slave will then program itself with the downloaded file. This will take several seconds and include a reboot.
5. The slave will enter the INIT state with the new firmware in place.

13.2 OVER USB

Flash updates via USB require a flash update application on a PC that contains the embedded binary image.

14 SUPPORTING DOCUMENTS AND FILES

These files are available from the www.watlow.com website.

WatlowRMZ.xml is the ESI file for the adapter.

RMZ4_xx_xx.bin is the flash image to send to the device over EtherCAT®.

ObjectDictionary_ETG5003_2060_Watlow_A.xlsx Specifies all EtherCAT® objects for the adapter.

RMZ_ModbusMap.xlsx Defines the object dictionary mapped to Modbus Registers. This is accessible over the RJ-12 Modbus Slave Jack. This is a convenient point for connecting a Watlow Silver Series HMI. This interface is set to 38400 baud, 8 data bits, 1stop bit, No Parity at Address 1.

15 TROUBLESHOOTING GUIDE

Issue	Likely Cause/Remedy
No LEDs lit on product	• 24V not present on CT connector pins 98/98
Device is not identified over EtherCAT	• Check Link LED on Ethernet RJ45 jack • Incorrect/no ESI file loaded in Master. Make sure to use the latest ESI, all past versions are supported in the latest ESI. When bumping up a product revision, make sure the master reloads the correct image from the ESI.
Can't enter Operational State	• User PDO not byte aligned for data elements following bit data type. All types other than bits must be byte aligned in the PDO image.
Optical inputs don't read back	• Map the loop to bus 4 (optical) in the 0x4nn0 objects • Verify Optical LED current level. High values indicate poor connection to the probe.
Optical inputs appear to read incorrectly	• Verify Probe Type (0x4nn1:0x14) setting matches the connected probe
Control Sensor input don't read back	• Sensors must be mapped to correct RM input module in 0x4nn0 objects
Limit Sensor input don't read back	• Limits must be mapped to correct RM input module in 0x4nn0 objects
Limits won't clear (relay pull in)	• The input must be between the Over-Temp and Under Temp points. • The limit function must be Both Sides, High or Low • The limit condition (0x6nnn:0x18) must be 0 (clear) • Clear the limit by writing to (0x3nnn:0x11)
Heater Current sense does not report values	• Verify the current sense is mapped in 0x4nn0 • The Current sense must be on the same loop as the control output and in the same RM module • The output must be conducting to get valid readings
Mapping does not appear to get data from inputs or to outputs.	• Each RM module must have a unique zone number • Verify the RMs are discovered by the RMZ in the 0xF5nn objects. Confirm zone numbers here.
Control loops don't product power	• Control State must be set to 1 in Output PDO • RMZ must be in OPER mode
Can't auto tune a loop	• The input sensor for the loop must be reading correctly (no input error) • RMZ must be in OPER mode • The loop must be in the On State and Auto Mode. • Start with the appropriate command 0xFB30
Controller setting are not maintained through a power cycle	• Issue a Non-Volatile Save command when the parameters are at the desired value to save them
RMZ does not show on my PC when connected via USB port	• Use the **WatlowUSB.inf** driver file for this virtual COM port
Can't flash load RMZ	• Mode must be BOOT to start a flash load • After loading, mode must be set to INIT to commit the new firmware.

16 RMZ4 SPECIFICATIONS

Feature	Specification
Supply Voltage	• 20.4 to 30V AC/DC 50/60 Hz • Compliant with SEMI F47-200, Figure R1-1 voltage sag • External supply should comply with Class 2 or SELV • Wire on slot “C” connector
Power	• 4 Watts Max, 14 VA
Environmental	• -18 to 65°C operating • -40 to 85°C storage • 0 to 90% RH, non-condensing
Agency Approvals	• UL /EN 61010 Recognized; c-UL C22.2 #61010; File # E185611 QUYX, QUYX7 • ANSI/ISA 12.12.01-2012 hazardous locations Class 1 Div. 2 • EN60529 IP20 • RoHS by design • W.E.E.E. • FM Class 3545 on connected RML, RMC, ST module • CE
Weight	• 200 grams (7 oz) without adder cards
Wiring	• Slot “C” connector • Touch-safe removable 12 to 30 AWG • Torque 0.8 N-m (7.0 lb-in) right angle
Mounting	• DIN-rail spec. EN50022 35x7.5mm
Control Loops	• 48 max, set by model number
Process Alarms	• 1 per control loop
Deviation Alarm	• 1 per control loop
Connected EZ-ZONE RM controllers	• 15 max
Compatible EZ-ZONE RM types	• RMC – Sensor inputs, outputs, limits, CT • RME – Outputs, CT • RMS – Sensor inputs, outputs • RMH – Sensor inputs • RML - Limits
Connected EZ-ZONE ST or PM controllers	• 8 max
Heat Control Mode	• PID
Cool Control Modes	• PID / On-Off
Control Update Tate	• 10 Hz
Ramp to Set Point	• Programmable in degrees per minute
Current Sense	• One configurable heater current sensor per control loop (resident in RME and RMC modules)

Over-Temp Limit	• Configures one over-temperature limit sensor per control loop hosted by remote FM approved RMC or RML limit module
EtherCAT® Device Profile	• ETG.5003.2060 Temperature Controller
Unique EtherCAT® Identifier	• Two switches – 0x10, 0x01 for ID from 0 to 255
EtherCAT® LEDs	• RUN and ERROR
EtherCAT® Connections	• IN and OUT RJ-45

EtherCAT® PDO configurations	• 2 sets per loop:
	  ○ One fixed default PDO set
	  ○ One user programmable PDO set by loop

USB	• Mini USB device providing a CDC serial port
Serial Connections	• Standard bus RS-485 on slot “C” connector
Bluetooth	• Serial Port Profile (SPP) streaming XML
Optical Temperature Sensor Inputs	• 4 max, set by model number

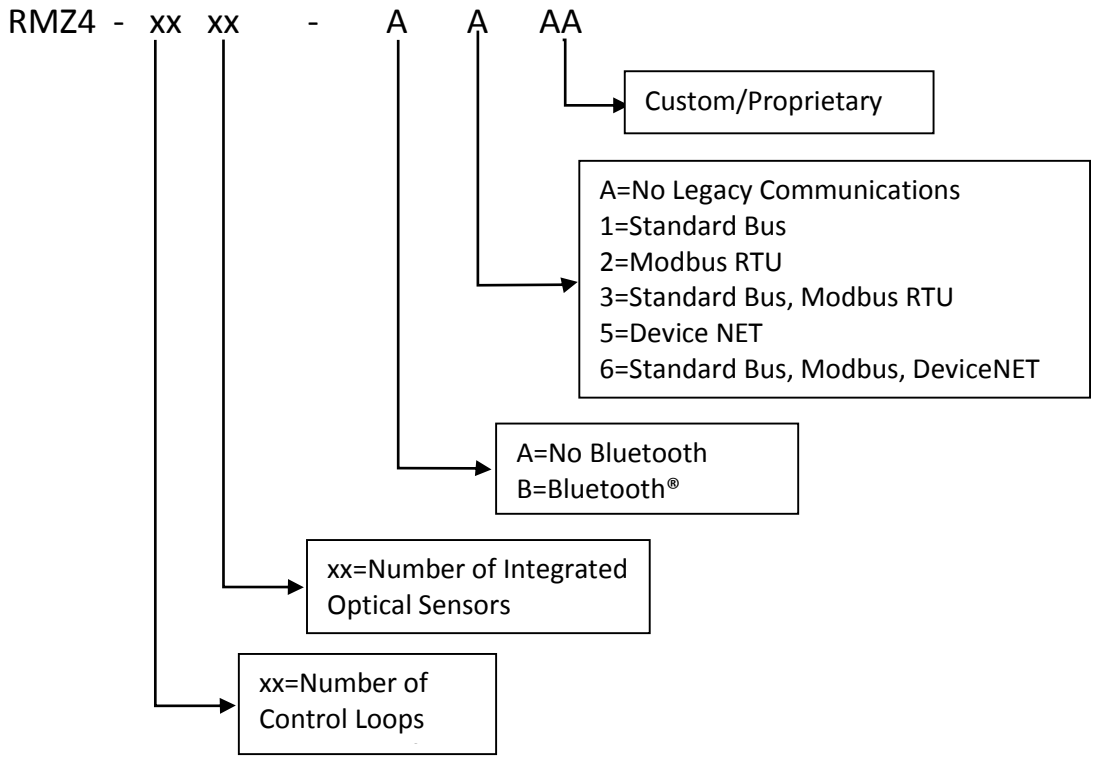
17 Optical Adder Card Specifications

Feature	Specification
Optical Temperature Sensor Inputs	• 4 max, set by model number • ST bayonet style connectors IEC 61754-2
Environmental	• -18 to 65°C operating • -40 to 85°C storage • 0 to 90% RH, non-condensing
Supported Calibrated Probe Types	• Type A – Watlow Standard • Type B • Type C – User Specific
Probe Range	• -150 to +450 °C Type A probe (Blue)
Accuracy (Unit to unit)	• ± 0.05 °C
Precision (Sigma)	• ± 0.1 °C
Resolution	• 0.0007 °C
Short Term Stability (Noise)	• ± 0.15 °C
Long Term Stability (Drift)	• ± 0.5 °C per year
Dynamic Sampling Rate	• 10 to 400 Hz
Weight	• 362 grams (12.8 oz) RMZ4 with 4 optical cards

Feature	Specification
Modbus Master Port	• Modbus RTU 8,N,1 • EIA-485 half duplex • Baud Rates 9600,19200,35400,57600 • Polls addresses 1 to 247
Modbus Slave Port	• Modbus RTU 8,N,1 • EIA-485 half duplex • Baud Rates 9600,19200,35400,57600
Extra Standard Bus Port	• RS-485 half duplex • Accepts connections from EZ-ZONE Configurator or Composer
Bluetooth Interface	• Bluetooth v3.0 • Bluetooth Design ID: B019224 • SPP Serial Streaming • SCPI messaging system – see RMZ4 Bluetooth Spec.

19 PART NUMBERING

This is the part number for the RMZ4 EtherCAT® Adapter.



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The Bluetooth® word mark and logo are registered trademarks owned by Bluetooth® SIG, Inc.

UL® is a registered trademark of Underwriter's Laboratories, Inc.

DeviceNet™ is a trademark of Open DeviceNet Vendors Association.

This device complies with Part 18 of the FCC Rules (Section 18.212).

Contains Transmitter Module

FCC ID: X3ZBTMOD5

IC: 8828A-MOD4

Bluetooth SIG Qualified Design, QD ID: B019224

Designed and Manufactured in the USA.

Declaration of Conformity

EZ Zone Series RM

CE

WATLOW Electric Manufacturing Company
1241 Bundy Blvd.
Winona, MN 55987 USA

ISO 9001 since 1996.

Declares that the following Series RM (Rail Mount) products:

Model Numbers:	**RM** followed by additional letters or numbers describing use of up to four module options of various inputs and outputs or communications.
Classification:	Temperature control, Installation Category II, Pollution degree 2
Voltage and Frequency:	SELV 24 to 28 V≂ ac 50/60 Hz or dc
Power Consumption:	RMA models 4 Watts, any other RM model 7 Watts
Environmental Rating:	IP20

Meet the essential requirements of the following European Union Directives by using the relevant standards show below to indicate compliance.

2004/108/EC Electromagnetic Compatibility Directive

EN 61326-1	**2013**	**Electrical equipment for measurement, control and laboratory use – EMC requirements, Industrial Immunity, Class A Emissions (*Not for use in a Class B environment without additional filtering).***
EN 61000-4-2	2009	Electrostatic Discharge Immunity
EN 61000-4-3	2010	Radiated Field Immunity
EN 61000-4-4	2012	Electrical Fast-Transient / Burst Immunity
EN 61000-4-5	2006	Surge Immunity (Reviewed to IEC 61000-4-5 2014)
EN 61000-4-6	2014	Conducted Immunity
EN 61000-4-11	2004	Voltage Dips, Short Interruptions and Voltage Variations Immunity
EN 61000-3-2	2009	Harmonic Current Emissions (Reviewed to IEC 61000-3-2 2014)
EN 61000-3-3[1]	2013	Voltage Fluctuations and Flicker
SEMI F47	2000	Specification for Semiconductor Sag Immunity Figure R1-1

[1]NOTE: To comply with flicker requirements cycle time may need to be up to 160 seconds if load current is at 15A, or the maximum source impedance needs to be < 0.13Ω. Control power input of RM models comply with 61000-3-3 requirements.

2006/95/EC Low-Voltage Directive

EN 61010-1	**2011**	**Safety Requirements of electrical equipment for measurement, control and laboratory use. Part 1: General requirements**

Compliant with 2011/65/EU RoHS Directive

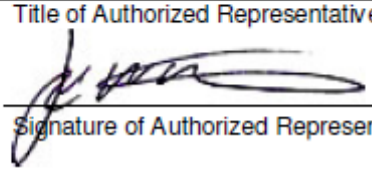
Per 2012/19/EU W.E.E.E Directive ***Please Recycle Properly***

Joe Millanes
Name of Authorized Representative

Winona, Minnesota, USA
Place of Issue

Director of Operations
Title of Authorized Representative

September 2014
Date of Issue



Signature of Authorized Representative